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THE EAST AFRICAN AGRICULTURAL JOURNAL

of

KENYA
TANGANYIKA
UGANDA AND
ZANZIBAR

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Vol. XII—No. 4

APRIL
1947

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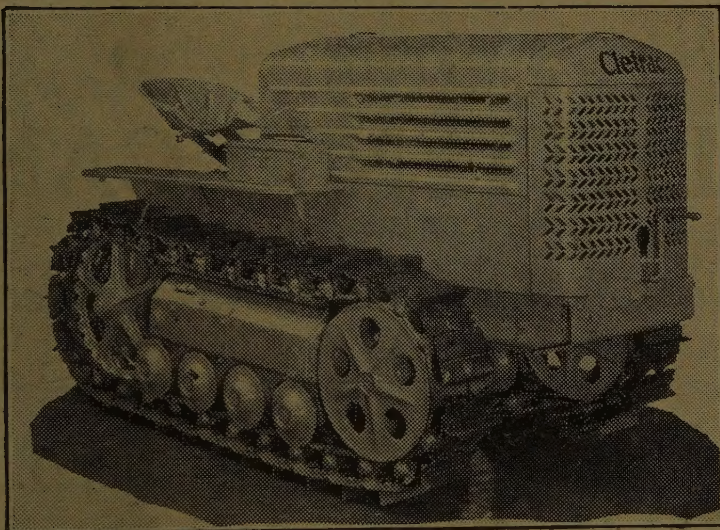

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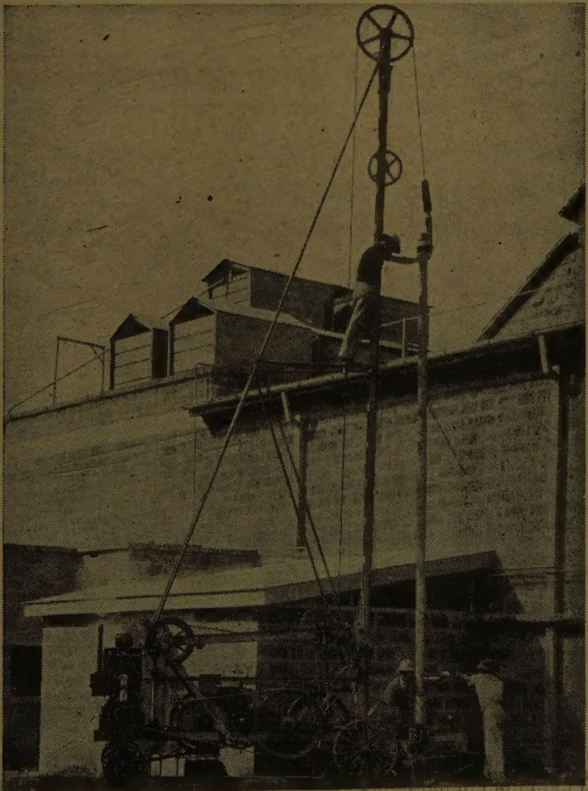

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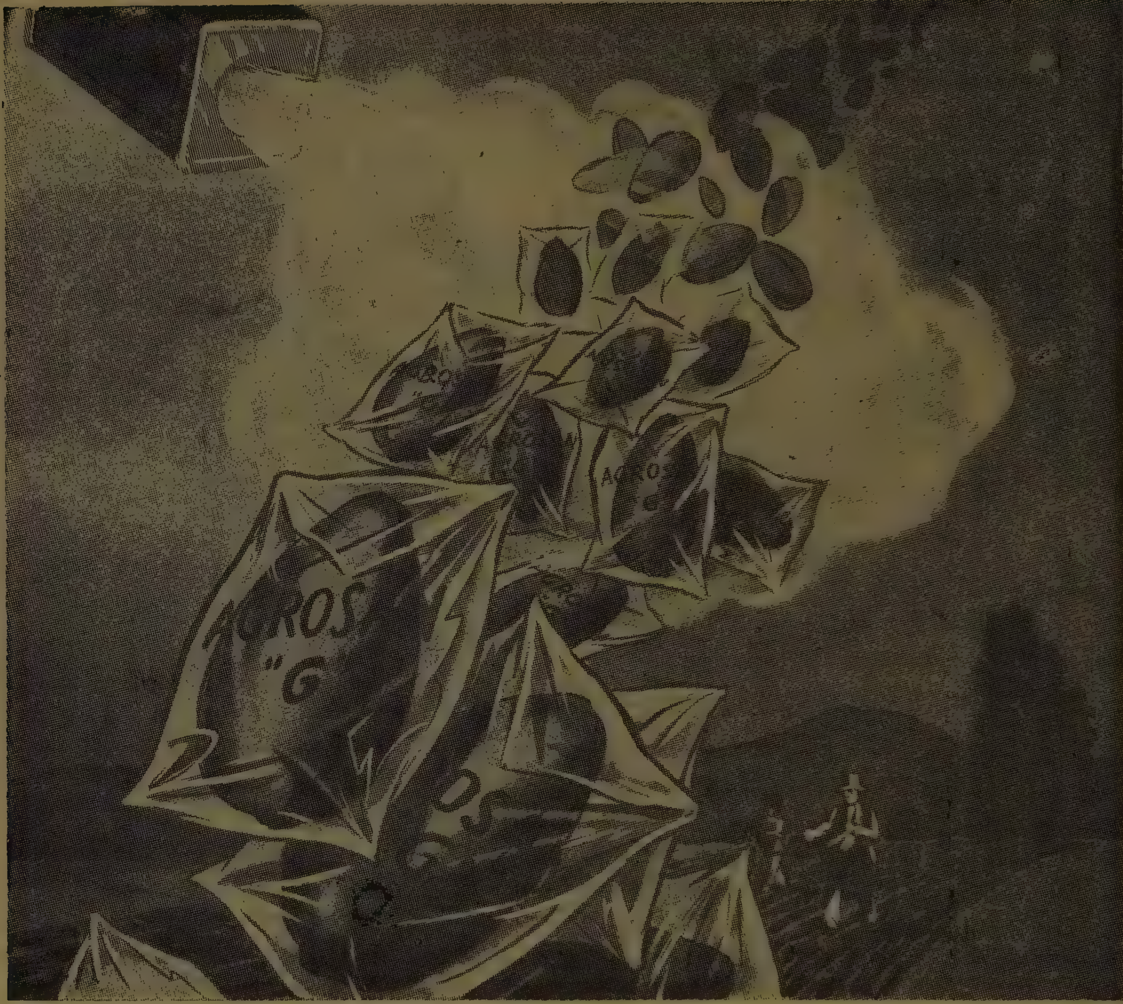

THE

EAST AFRICAN AGRICULTURAL JOURNAL

Vol. XII APRIL, 1947 No. 4

Issued under the Authority of the East African Governors' Conference and published every three months—July, October, January, April. Volume consists of four issues (commencing July issue).

Subscription Sh. 5 per volume including postage, payable to the Business Manager, the Government Printer, P.O. Box 128, Nairobi, Kenya. Subscribers are advised to remit postal orders in payment, otherwise bank commission must be added in the case of cheques.

Editorial correspondence should be addressed to the Editor, Amani, Tanganyika Territory.

The Editor does not hold himself responsible for opinions expressed by contributors.

Matter submitted for publication should preferably be sent through the local member of the Editorial Board. Manuscripts, drawings, photographs, should conform with the recommendations contained in *Notes for Authors*, which may be obtained from the Government Printer, Nairobi. *Double spacing should be used in typescript.*

Contributors receive 25 prints of their articles free. Additional copies may be obtained on payment if asked for in advance. Prints bear the same page numbers as the original articles in the *Journal*, except where, to meet a contributor's wishes, prints are supplied before publication has been completed.

Readers are reminded that all agricultural inquiries, whether they relate to articles in the *Journal* or not, should be addressed to the local Director of Agriculture, and not to Amani.

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THE FORESTRY ADVISER'S VISIT TO TANGANYIKA

The colonial development plans which are now being put into effect have stimulated interest in the work of the territorial departments, and the policy is now being adopted that advisers to the Secretary of State should have closer contact with the workers in the Colonial Empire. This principle is welcomed by technical officers in the Colonial Service, who have felt in the past that their work was being collated and criticized in London by men who had great difficulty in appreciating the conditions under which the work was being carried out. Thus the recent visit to East Africa of Mr. W. A. Robertson, Forestry Adviser to the Secretary of State for the Colonies, gave officers of the Forestry Departments an opportunity to put their problems to a man of wide experience and to explain and demonstrate the difficulties which they meet in the course of their work.

All technical advisers seem to arrive by one 'plane and leave by the next, but Mr. Robertson spared no pains to make the fullest use of the short time at his disposal and to see every aspect of the departmental work in Tanganyika.

Situated as he is at home between the subterranean rumblings of the Underground and the overhead booming of Big Ben, he must have read many a jeremiad from the Forest Officers of the Empire, but for the last two years he has had the sound sense to migrate in winter in order to see for himself. His qualifications for seeing clearly are unique because he had 25 years' experience in Burma and India where he started as an Assistant Conservator of Forests in a Division, switched for a time to teaching in a Forest School in Burma, then went on to central research at Dehra Dun. For many years he was Utilization Conservator of Forests in Burma where he doubtless learned all the idiosyncrasies of the elephants that piled the teak, and was not in consequence worried by delays in delivery of machinery or spare parts; and he had the good fortune to deal with one of the most valuable of the world's timbers. At a comparatively young age all that was "left behind him" and he found himself instead amidst the beech woods of Buckinghamshire in charge of the Forest Products Research Laboratory at Princes Risborough, where he remained for over ten years. One of his hobbies has been travel and to be with him for any length of time was a liberal forestry education, because in addition to the Far East he has seen the forests of North and of Central Europe, of France and of Germany, of North, South and of Central America, of West and South Africa, with some previous knowledge of those of East Africa, of the West Indies, of China and even of the Antipodes. All these places he had visited mostly on forestry business, so few men could be more capable of assessing what had been, or, more important perhaps, what had not been done in Tanganyika. If he found more of the latter than of the former, he was too courteous to say so or to blame those who had done their best in conditions of considerable adversity.

His impressions of the Territory have already been briefly conveyed to the local Press in an interview he granted to them. It would be wrong at this stage to anticipate his recommendations to the Secretary of State even if these were known. His four weeks' stay included visits to all except the Southern Province of Tanganyika and these were made by various means, on land, by rail and by road, and in the air. In those weeks a mileage of 2,750 was covered, an average of 100 miles a day. Cooped up in a light aircraft with the Silviculturist, he saw our dry forest, the vast *miombo* which as a forest type is by no means inspiring, particularly seen from above, miles and miles of it. Perhaps he found consolation, though not at the time of his journeying, in the extent of this formation, since he thinks that future forestry possibilities must lie largely in that zone which has been reserved only by its being the home of various species of tsetse fly. On the analogy of work done elsewhere and particularly in Northern Rhodesia which he has seen recently, Mr. Robertson counsels early reservation of large tracts of forest of this type and, in order to avoid the mistakes made in other territories, he advises reservation ahead of mining development. The lessons of the Rhodesian Copper Belt should be applied here if we are to avoid the desolation which has resulted there through neglecting sound forestry practice. This policy tallies with that advocated for Tanganyika in 1935 by the late Professor Troup, and it might have been applied to a much greater degree had war not intervened with consequent staff reductions and cuts in financial provision. The Adviser was of opinion

that ample timber resources exist within the Territory for all foreseeable mining purposes, but that if these are to be used to the best advantage we must act soon. Wasteful exploitation should be discouraged by all means at our disposal; more secondary timbers should be used with or without some form of impregnation, reafforestation in some form should always accompany or shortly follow exploitation, and mining companies should be prevented from making the vast farm clearings which have devastated other regions.

By 'plane Mr. Robertson went from the Eastern Province to the Southern Highlands: he traversed the Western, Central and Lake Provinces from south to north and thence flew to the Northern Province, landing at Arusha. After a surfeit of dry zone forest, it must have been a relief to see the green forest fringes of Meru and Kilimanjaro, even if his flight there revealed gaps in the boundary lines, minor encroachments and the imminent problem of fire protection which was all too evident. In the year that he had chosen to visit us, largely by unseasonal rain, he was spared the sight of the extensive forest fires which he could not have failed to see in the previous dry season. As the best means of preventing extensive annual damage by grass fires which cross the tree line and reduce our forest resources by a steady process of attrition, his remedy is early burning but he realizes all too well the obstacles to the general application of this policy.

Brought up in a very strict school, the Forest Adviser was apprehensive about the inroads which had been made on our tenuous forest estate for a variety of purposes and was of opinion that legislation might require stiffening up to ensure greater security of tenure in the future. He favours the Indian procedure of a settlement court before gazetting all reserved forests and that all rights whatsoever should be clearly defined from the start. The court's decision should then be followed by clear and final demarcation of all boundaries. In these respects he feels that forest reservation in Africa generally has not been sufficiently definite, and that neglect of these governing principles has led to much trouble and misunderstanding.

He was agreeably surprised by the interest shown in forestry by all classes of the community, unofficial as well as official, and by the goodwill which all showed towards the Forest Department, and he thought that in this respect we were fortunate as compared with many other countries which he had visited. Another respect in which he found things better than he had expected was in the efficiency of our local exploitation. Apparently, from what he saw, he thought that too black a picture had been painted. As this is the aspect of forestry work on which he is most qualified to speak, it is encouraging to those who have endeavoured to work up an efficient milling industry to find that their work has not been altogether in vain.

It was most interesting in travelling round with the Adviser to note the reactions of those, particularly in the wood-working industry, with whom he had contact. Usually the meeting seemed to start with mild scepticism on the part of the local sawmiller. The attitude at first was, "What can one who spends his time in an office in London teach me about my job". Soon, as the conversation proceeded, this changed to "Well, he does seem to know what he is talking about", and then, should the talk be on "fillers", or on the set of saws, the speed of engines or the various processes of the manufacture of fibre board or plywood, valuable information and advice were given and gratefully accepted. Then, most affably, the local man took leave of the home expert feeling that he had been told something or, at least, that his varied problems had been fully understood and sympathetically considered. This happened not once but many times.

On territorial forestry research Mr. Robertson had many wise things to say. He is of opinion that high precision work on timber structure and uses is not a responsibility which should lightly be assumed here in East Africa, since facilities now exist for this to be done at minimum cost to Colonial Governments either at home at Princes Risborough, or in the Union of South Africa. We should confine ourselves to application and to workshop tests which can be carried out locally without highly trained staff or expensive equipment, neither of which is readily available now or likely to be in the near future.

He is in favour of setting up a Working Plans section but considers that as a preliminary measure a great deal of rechecking of existing data should be done, since he rightly points out that accurate growth figures for all the more important species are essential to any attempt at planned exploitation on a volume basis. He therefore advocates a carefully planned programme of sample plots for all our more important economic species. This

in itself, he considers, will absorb the full time of all the officers whom we are likely to be able to spare for silvicultural and other research for many years to come. Meantime he prefers district working schemes rather than more intensive plans for more limited areas. These should be correlated with district planting plans although natural regeneration, promising in respect of certain if not all of our local economic species, should not be overlooked. His opinion is that in the past there has been an undue concentration of effort and expense on protection, and that the time has come to develop our forests economically instead. War-time timber production has encouraged the local sawmilling industry to efforts which would have been considered impossible in pre-war days. It remains now to apply the lessons then learned to the conditions of peace, and Tanganyika should be most favourably situated to meet the export demands particularly of the South African market.

Mr. Robertson saw the largely abortive attempt to get a Rangers' School going again at Olmotonyi and was of the opinion that, while praiseworthy, it seemed to be ill-equipped as regards classrooms, staff and equipment. Perhaps in the future it will be possible to devote more money to this important work but so far we have not been able to do more than get it going in a very modest way.

It remains, however, to ensure to those who have laboured for many years with little incentive or recognition, that ample staff is forthcoming and regular financial provision for development is assured in the future. It is in this connexion that the Forestry Adviser's visit should, we trust, serve to stimulate Whitehall as his visit has certainly stimulated all who had the good fortune to meet him.

It is to be hoped that development plans for the Territory will soon be approved when it will be possible to make a start on the solution of many forestry problems which should have been tackled many years ago but which have had to await, as have many other urgent problems, more propitious times for their implementation.

W. M. R.

We are to-day breeding a new strain of scientists and agronomists. They are wiser as to the political and economic background of their work than were their fathers, and they are beginning to realize that, if they are to be drafted into the colonial field, they must have some voice in the administrative and social reforms that will be required to render their work fruitful and of enduring value to mankind.

F. Le Gros Clark in "Discovery", December, 1946.

ARTICLES FROM EUROPEAN FARMERS AND PLANTERS

The Editor is anxious to publish practical articles on farming subjects written by European farmers in East Africa. Articles should be 900 to 4,000 words in length and, if possible, typed at double spacing. Articles in manuscript can be accepted if authors have no typing facilities.

SOIL CONSERVATION ORGANIZATION IN FORT HALL DISTRICT AS ADAPTED FROM THE INDIGENOUS "NGWATIO" SYSTEM

By J. Hughes Rice, Assistant Agricultural Officer, Kenya

(*Received for publication on 24th February, 1947*)

From time immemorial Bantu tribes have followed the practice of communal assistance in many of their clan activities, ranging from clan warfare to agriculture and the building of huts. The main authority has been vested in the tribal elders, who have been accepted as elders by virtue of their wisdom and powers of leadership, and their councils direct the lives of the people in their areas. The actual communal assistance or *ngwatio* was not, however, directed originally by the elders, but was a purely "good neighbour policy" whereby mutual help was given in need by groups of neighbours.

The basis for development of the soil conservation campaign in Fort Hall was the organization of these existing indigenous tribal groups, and the welding of them into a land authority responsible not only for the administration of the tribal customs in marriage and litigation, but also for the maintaining and restoring of fertility of their lands.

Thus the commencement of the plan was the formation of the elders in a locality into a body responsible for directed communal work on the land. The *Itura* or what would most nearly correspond to our parish, was the smallest existing organized group of elders. It was found that the average size of such an *Itura* unit was about 1½ square miles in area. Each chief of a location was made responsible for guiding the headmen of his sub-locations in the organization of his *Itura* groups. Sub-locations consist of from four to eight *Ituras*, all of which have their existing council of elders who wield the indigenous tribal authority and custom.

In larger locations there are as many as 48 *Itura* groups, all of which are working as independent units on activities connected with the land, and who are responsible under their sub-location headmen to the chief for turning out on communal work, as described hereafter.

Plan

In the first instance, some clear plan of action is essential, as in war. For various orders or exhortations to be sent to locations, and for the chief to be left to carry them out as best he can, is doomed to failure. The average African has no ability to organize a method on his own. To tell all the Africans that terracing is a good thing, and to go and do some, is not good enough. They must be told how to organize the work, in fact they need the military sequence of orders:—

Information

(*a*) *Enemy*.—Land going to ruin because of unchecked run-off of water; erosion is gaining ground, etc.

(*b*) *Own Troops*.—There are many Africans, and if they unite and each does a small contribution without stint, the job can be done. All able-bodied people in each *Muhiriga* will assist in soil conservation work.

Object

To make their reserves more prosperous and fertile so that they and their descendants may live in prosperity and happiness, without fear of want, ill-health and famine. All existence itself, and trade, entirely depend upon the fertility of the land, which is the basis of every activity in the world.

Method

The chief will call his headmen to a meeting with the agricultural officer, and this officer will describe to them how to divide their sub-locations up into suitable groups. The *Itura* proved to be the most satisfactory with an assistant agricultural instructor in charge of each three *Ituras*, to assist the headman with all agricultural organization, and levelling. Each group does two days per week. A *Kiama* of elders and *Athamaki* are formed to direct each group and exercise control under the headman, and are responsible for calling the people out to work on the appointed days, and for deciding on what lands will be dealt with. Only the actual technical part is in the hands of the department.

Administration

Itura "A" will work on Monday and Tuesday, "B" on Wednesday and Thursday, etc. The assistant agricultural instructor will arrange to measure out ahead of the terracers. The *Itura* elders will detail six men to assist the assistant agricultural instructor in pegging, on the two days on which they work. All sick, aged and pregnant persons are excused duty.

Those with special pleas for leave off (cases, etc.) will apply to *Kiama*.

Each *Muhiriga* group will have a roll of members, and the *Kapiten* (Captain) or overseer appointed by his *Itura* will tally up all the people at work. Those absent will be investigated and if defaulting, will be taken before their *Itura Kiama*. The elders have their own little ways of dealing with minor offences or absenteeism, which do not clash with the civil law—a pot of beer supplied for the delectation of the *Kiama* elders is a simple one. If the offence is more serious, report is made through the headman and chief to the administration. Where wilful damage has been done to soil conservation work, the man will go to the native tribunal. If he consistently defaults or refuses to work, he will be disowned by his *Itura*, and be dealt with under the Soil Conservation Regulations or the Native Authority Ordinance and Standing Resolutions of Local Native Councils.

All workers will turn out in the early morning as soon as light, but not before. The task will be 25 running feet of terrace per man and wife. This will be inspected by the *Kapiten* before leaving the work. It is hoped that all tasks will be finished by 9 a.m.

Tools are only available at present in small numbers, but it is hoped that Government will provide many more at an early date.

In the season when crops are on the land, reclamation of eroded hill-sides will be carried out. When crops have been harvested every effort will be made to terrace cultivated lands, but the African needs to have it all worked out for him.

Command and Leadership

Before any order is given, the agricultural officer should satisfy himself that his scheme is workable and for the good of the community. He will then see that the chief and his elders see it through. If a few natives fail and are not brought to book, the whole scheme will collapse.

Administration

Where these soil conservation plans break down, it is essential for the agricultural officer to go in at once and enforce the Standing Resolutions. If the chief does not give sufficient support, the administration must see that he does. The wholehearted support and co-operation of the administration is essential to success.

Chiefs

An enormous amount depends upon the chief. If he is active, keeps his headmen going, and does not allow any *Ituras* to neglect their responsibilities, or reports them to higher authority, there will be no trouble. In almost every instance the people are willing and co-operative when given a lead, and realize that orders are to be obeyed. When the chief or elders let their friends and relations off, or accept small gifts to excuse influential men, the trouble starts amongst the remainder and work declines. The chief is almost the most important factor in the organization and can make or mar its success. This is where the administration can help so greatly.

Putting Agriculture Over

This depends largely upon the enthusiasm, linguistic ability, and general personality of the officer. Patient, picturesque, palatable and simple explanation is necessary of the why and the wherefore of everything, and the profit that can accrue from good farming. Use of the blackboard at all meetings to show calculation of relative profits from good and bad farming methods work with the Kikuyu tribesmen in a noticeable way. Diagrams and allegedly amusing drawings also help. Information Office photographs and posters also rouse great interest, when explained. "Sand tables" for demonstrations are also excellent value, and showmanship goes a long way.

The people generally are most receptive of instructions and advice, and their co-operation in this soil conservation drive has been truly remarkable, and continues to be in spite of present shortage of food. These Africans are in the main only too conscious of the deterioration of their lands, and are keen to do something about it, when they can see *how*, and that the work they do is of immediate benefit to their own farms. The whole scheme is organized so that no family has to go far to work, and the community area is of such a size that even if terracing is not being done on an individual's land this week, it may easily be so in a week or two.

These units which have been built up—in the main by the people themselves with some guidance and suggestions—are very suitable for possible co-operative development, which is under consideration, and it is hoped to try out a Co-operative Farming Group shortly.

The aspect of the scheme which appeals so much to the people too, is that it is being run by themselves for themselves, with only indirect control by Government.

Glossary

Ngwatio = Communal help.
Itura = "Parish".
Kiama = Council.
Athamaki = Leaders.
Muhiriga = Clan.

REVIEW—EROSION IN THE PUNJAB

By Colin Maher, M.A., Dip. Agric. (Cantab.), A.I.C.T.A., Senior Soil Conservation Officer, in charge Soil Conservation Service, Department of Agriculture, Kenya Colony

It is a melancholy fact that British rule and British peace have so often had the result of producing conditions which are only too likely to lead to future wars, as growing populations are forced by deterioration of natural resources to find living space elsewhere. Before British occupation "wars were frequent and kept the population in check, life was hard and it was impossible for flocks and herds to travel long distances with safety, as they do now, in search of fresh pastures. Consequently flocks and herds were limited to the numbers that the country could support. There was no market for timber and the forests were unfelled. That they were frequently burnt for cultivating arable crops is evident from the numerous remains of terraced fields in the forests": this might have been written about parts of Africa but in fact it refers to the Himalaya districts and is quoted from a report entitled "Erosion in the Punjab, its Causes and Cure", by Sir Harold Glover, late Chief Conservator of Forests, Punjab.* This report, dated November 14th, 1944, was written at the request of the Punjab Government, to survey progress which had been made in restoring eroded lands of the Punjab after five years work by a newly-formed, special "Soil Conservation Circle" of the Forest Department. The author had been in charge of the Punjab Forest Department for the first four years from October, 1938.

The report consists of two parts, the first a general section for readers not specially interested in particular districts. The second part describes conditions in various districts in the Punjab and makes recommendations for the assistance of district officers.

The report is bountifully illustrated with a large number of excellent photographs which made the worst erosion shown in photography from the U.S.A. appear trifling. It is difficult to believe that even the most distinguished visitors to the Punjab would be inclined to doubt the reality of the devastation caused by erosion or to demand experimental evidence of a decline in crop yields due to soil loss. According to Sir Harold Glover the regions of the Punjab (which has an area of nearly 100,000 square miles) in which soil conservation is of supreme importance are—

(a) the Himalayan tract, 22,000 square miles (inclusive of states) with a population which could not exist on agriculture alone, unsupported by grazing, forest rights and forest work;

(b) the North-West tableland (11,000 square miles), a precarious tract, whose inhabitants are warlike tribes which form the backbone of the Indian Army;

(c) the submontane belt of the North-East (8,000 square miles), very fertile and thickly populated, its population of five millions being mostly agricultural.

The survey is not concerned with the irrigated central districts of the Punjab, except so far as the rivers are affected which supply water to the irrigation canals.

Population Pressure

Erosion and over population being so closely connected it is not surprising to learn that the population of the Punjab had risen from slightly over 20½ millions in 1921 to 28½ millions in 1941, or a rise of nearly 40 per cent. During this period of 20 years the rural population increased from 18½ millions to 24 millions, an increase of approximately 30 per cent, 85 per cent of the people being dependent on agriculture. During the past 20 years the population of India as a whole has increased 27 per cent or by about 100 million people, whereas the total area under food crops has increased by only 1 per cent. It has been stated that there are only 0.72 acres cultivated per head of the population of British India, compared with the 2½ acres per head which are said to be needed for even a modest peasant standard of nutrition.

This is the background for erosion; people and stock pressing on one another and on the land—in India, China and Africa; the background for famines, for the operation of political pessure groups—for atomic warfare? In a brief appendix to this report the Director of

* "Erosion in the Punjab: Its Causes and Cure" by Sir Harold Glover, pp. 143, published by The Civil and Military Gazette, Ltd., Lahore, 1944, price Rs. 15-7 or Sh. 23.

Agriculture for Bombay Presidency states: "In many districts of the Bombay Province, particularly in the southern and eastern areas of the Deccan plateau, soil erosion is very serious. The consequent loss of surface soil and the lack of rainfall conservation in the eroded fields are the principal causes of the recurrent famines or crop 'scarcities' in the Deccan tract".

Sir Harold Glover says: "The fundamental cause of the erosion of the soil is economic. A dense and expanding population endeavours to make a living by clearing the forest for shifting cultivation; by cultivating fields on steep and unsuitable slopes; by methods of cultivation which are faulty in that they do not permanently conserve the soil; by grazing hordes of animals in the forest and village pastures and by lopping trees for fodder until all vegetation has been so reduced that it no longer affords protection to the soil".

Elsewhere he says: "A lower standard of living is the necessary result of the erosion of the soil. In some districts, for example Jhelum, there has been an actual decrease in the arable area; in all submontane tracts the fields yield less as their fertility has been lowered owing to the loss of top-soil, while holdings are already very small . . . . ".

"The pastures are bare, and the cows give but little milk, the children are undernourished and their physique is poor. Malnutrition and deficiency diseases are prevalent over wide areas of the Inner Himalayas, where the menial classes in particular are living in abject poverty. In Kanawar, on the borders of Tibet, polyandry is universal, and has been resorted to as an economic necessity in order to limit the increase of the population".

He adds that: "Over-population accentuated by the loss of soil by erosion and an actual reduction in food supplies is common throughout the Himalayas and the foot-hills and the real cure would be mass migration, but this is out of the question as there is nowhere for the people to go".

We seem to have heard something like this before somewhere in Africa.*

THE EROSION PROBLEMS AND MEANS SUGGESTED FOR THEIR SOLUTION: FOREST GRAZING

A large part of the difficulty in protecting the mountainous districts of the Punjab is due to the dependence of a large part of the population on the forest lands. It is brought home to the East African reader how fortunate it is that Crown Forest Reserves were early established in East Africa—although there is unfortunately even now some demand for these reserves to be reduced in order to increase the land available for both European and African settlement. Lopping for fodder and grazing and browsing by excessive numbers of cattle, buffaloes, camels, sheep and goats, together with the trampling of these animals, has killed out the forest trees on steep and even precipitous slopes in many areas of the Punjab, and these areas have been reduced to virtual barrenness by erosion. The browsing of the smaller animals has prevented regeneration of the trees, except in specially protected or demarcated forests.

Powers exist under the Indian Forest Act to close compulsorily to grazing protected forests, provided that a sufficient area is left for the satisfaction of the villagers' rights. Special legislation for village waste, not specified as forest under the Indian Forest Act, was provided by the Land Preservation (Chos) Act of 1902.† This act originally was applied to the notorious Siwalik hills, but in 1942 was extended to the Kangra district in order to permit of the eviction of sheep and goats from the catchment area from which the Punjab hydro-electric scheme derived its water. The *Chos* Act was amended in 1944, improved, and extended to the whole of the Punjab. It is stated, however, that powers under this act to close forests compulsorily have as yet only been used occasionally as the villagers, fearing compulsion, apply voluntarily for their forests to be closed.

In some areas rotational closing was applied, but the areas left open to grazing have been found to be seriously over-grazed. At a later date portions of the mature forests were closed in rotation for regeneration, either by natural

* Yet a writer in an Indian paper published in Nairobi a few months ago quoted from the book of one Professor Radhakamal Makerjee in which the latter, referring to Africa, stated that "The estimates of the population capacity of the whole continent fluctuate between 1,000 and 2,300 million persons". The population of Africa according to Lord Hailey (1935-1938) was about 110 million people. The population of the whole world is generally estimated to be about 2,000 millions. It is interesting to read the point of view that so far from there being nowhere for surplus African populations to go it would be possible for Africa to carry twenty times the population, indeed more than the whole world's population—at a living standard unstated.—C.M.

† A *Chos* is a torrent bed filled with sand or boulders.

means or by artificial plantations. Abundant grass has been found to grow in these areas and this has in many cases materially reduced local opposition to the closures. The grass is often used for fodder, but the grass *Bhabar* (*Eulaliopsis binata*) is also used for rope-making or for profitable sale to paper factories.

While photographs show incredible devastation of formerly wooded slopes it appears that closure results, in many areas, in a speedy return of an effective vegetative cover. A point of interest is that it has not been found possible to plant in an eroded soil trees or plants which are high up in the plant succession. Bushes such as *Dodonea viscosa,* common also in East Africa, and *Acacia* spp. have to be planted first or the grass *Bhabar* (*Eulaliopsis binata*) which flourishes on eroded soil in the Siwaliks.

The Torrents or Chos

As a result of the increased run-off from the denuded slopes great torrents of sand, or of stones and boulders, pour off the lower slopes of the Himalayas and from the Siwaliks and other hills. This is a phenomenon which is generally only met with on a relatively miniature scale in East Africa. These torrents or *chos* constitute major problems of soil conservation in the Punjab. In Hoshiapur these torrents of sand burst from the denuded hills about the middle of last century. At first the *chos* brought fertile silt and their presence was welcomed by the people; but, in a few years time, instead of silt came sand, which overlaid the fields or destroyed them. The courses of the *chos* were capricious and changed every few years to destroy fresh fields in neighbouring areas, until finally lakhs of acres had been destroyed or their fertility had markedly decreased. These torrents of sand dominated and upset the whole agricultural economy of the district. The following statistics connected with the land are of interest:—

	Acres
Area of district	1,415,715
Cultivated area of district ..	751,137
Hill waste and torrent beds ..	664,578

The first necessity is to restore a vegetative cover to the upper slopes of the catchment in the endeavour to reduce the vehemence and quantity of the flood run-off. The desirability of this is exemplified by the statement that the Budhki *chos*, which is conveyed over the Sirhind irrigation canal in an iron trough, is reported to roar over in flood 10 to 12 ft. deep and 132 yds. broad. This *chos,* which has a contributory catchment area of 86 square miles has a rate of flow of 65,000 cusecs of silt-laden water, but is dry in a few hours.

Absorption of moisture on the hill slopes and the restoration of tree growth or other vegetation is facilitated sometimes by the digging of contour trenches; but Sir Harold Glover, who evidently is much more at home with the ecological approach than with engineering methods, does not think highly of the value of such work as a general rule. It may be agreed, indeed, that ecological methods have more value in East Africa as a whole, also, than results obtained by the more spectacular and downright advance of the bulldozer. I have read with astonishment proposals by, presumably, "laymen" in the field of soil conservation to smooth out the land surface, both in India and in Africa, where it has been torn and seamed as the results of man's misuse of the soil and vegetation, by means of fleets of giant tractors, bulldozers and excavators. Such means largely escape the administrator's bugbear, ordering and compelling the reluctant local inhabitants to carry out, or refrain from, certain actions; but even the enormous potential power and wealth of modern man must have some reasoned priority of application. The cost of moving "dirt", as the Americans call it, is not often less than Sh. 1 to Sh. 2 a cubic yard, often much more, and the filling in of gullies in eroded areas could consume an astronomical number of shillings—and the power of gravity and running water would soon restore the scene to its original desolation.

In the Punjab it is attempted to control the torrents themselves by means of training them by small earth banks or "bunds" reinforced by live hedges made by planting stakes of various bushes and trees, including *Jhingan* (*Lannea grandis*), branches of *shisham* (*Dalbergia sissoo*), assisted by planting *sarkana* grass (*Saccharum munja*). *Kahi* (*Saccharum spontaneum*) soon appears and spreads rapidly. Cuttings of *Ipomea carnea,* which is not palatable to stock, are also planted on the banks or in the bed of a *chos* and may grow ten or fifteen feet high. The aim is to secure the accumulation of silt behind these live hedges of mixed vegetation to restrict the water to a defined bed. At a later stage the villagers hope to reclaim land from the old beds of the *chos* themselves, which may be up to three-quarters of a mile or more in breadth. It is plain, however, that if the tendency of these

sand-filled stream beds to meander has not been checked and unless the amount of water carried in flood has been reduced, optimistic cultivators are liable to suffer disaster.

SOIL CONSERVATION METHODS ON AGRICULTURAL LAND IN THE PUNJAB

It seems that extremely steep land is cultivated in the Punjab. Land slips and avalanches are frequent in some areas as a consequence. The tolerance of local officers in regard to slopes deemed suitable for cultivation is illustrated by a remark by the author of the report under review in which he refers to a severe storm which caused damage at Duir in the catchment areas of the Himalayas, observing that amongst the obvious remedies would have been: "The proper terracing and walling of the cultivated fields. *A slope to the surface of the field of 1 in 10 to the horizontal would probably be sufficient to reduce the velocity of the run-off*". (My italics—C.M.) In Kenya Colony a 10 per cent slope is considered to be highly erodible and nearing the upper limit of slopes fit for cultivation under the protection of broad base terraces.

The soils of the parts of the Punjab which are under consideration consist of alluvial soils, clays, and soils derived from sandstone rocks or from rocks of the Archean system, which are generally highly erodible. Rainfall varies in various districts from 7 to 115 inches annually. Even in the drier districts, however, such as Hoshiapur, with 36 inches, two-thirds of the rainfall may fall in three months during the South-west monsoon.

The usual method of controlling erosion is nothing if not arduous. Small dam scoops or *karrahs* are used, each drawn by two oxen—and very small, ill-nourished oxen they are in some of the photographs. Fields are roughly levelled into large bench terraces surrounded by peripheral banks known at *wattbundi*. Sometimes uneven fields are ploughed that the loose soil may be moved downhill by erosion. Terracing "bees" as the Americans would call them, gatherings of villagers for terracing, in common, with their *karrahs* and oxen, are held in some districts and are known as *mangalis*. These are social events in which work is done to the beat of drum; "refreshments are provided". Sir Harold Glover states that "An ideal party consists of ten *karrahs* and two ploughs drawn by 24 bullocks, three men being employed with each pair of bullocks, the party being completed by a drummer and two cooks. Three meals are provided at a cost of about Rs. 40, firewood for cooking and curdled milk for drinking being provided by the men. They work very hard and eat heartily and do about six hours work, in which time they level and embank one of the following: 3½ acres of land which has recently gone out of cultivation (Rs. 11 per acre); 2 acres of old abandoned fields (Rs. 20 or Sh. 30 per acre); 7/8ths of an acre of land which has been classed as ruined land at Settlement (Rs. 45 or Sh. 67/50 per acre). The acreage reconditioned depends on the eroded condition of the land. The method is cheap and popular and has the advantage of being indigenous to the district". In semi-arid regions such as Baluchistan, water is led into the flat embanked fields from the barren hillsides. It is not uncommon for banks to burst where fields have been insufficiently levelled, or for a *chos* to get out of control and burst over the fields. Stone walls are built to enclose the fields in some districts, while stone walls are used similarly in the beds of some *chos* to form fertile terraced fields which are irrigated partly by piped water from springs and partly by inundation when there is a flood in the valley. The main valleys are often well below the level of the cultivated lands and arable lands are not only subject to destruction from above by *chos* running off the overgrazed hillsides, but from below through ravines, tributary to the main valleys, eating back into the fields.

Nakas or small weirs are built to allow of the escape of storm water from field to field and larger weirs along the main lines of drainage. The construction of these weirs, built in brick or stone, has become traditional and must need considerable skill. The violent, if short lived, floods which are experienced must be very hard to deal with, and indeed failures are not infrequent. Often these weirs are built by communal effort and at common expense. "Progress by voluntary effort"—in building these weirs—"is slow and it is likely that compulsion will be resorted to where the laziness and neglect of one owner may ruin the effort of the community. This is now possible under the Punjab Land Preservation (*Chos* Amendment) Act IV of 1944".

It would be expected that the expense of building these brick or stone structures would be extremely heavy. For Rawalpindi, referring to weirs (sizes not stated) "a strong brick cement weir costs from Rs. 300 to Rs. 1,000 (Sh. 450 to Sh. 1,500), and the average cost of a weir in the main *nullah* is Rs. 500. The

Forest Officer estimates that for each acre reclaimed the cost on skilled masons and materials (bricks at Rs. 40 per thousand) will be:—

	Rs.
(*a*) Very badly ravined land with steep slopes	400
(*b*) Moderate ravines	125
(*c*) Gentle slopes	25

In addition to the above, unskilled labour is provided by the villagers themselves at their own cost for terracing, levelling and embanking the fields. He estimates the average cost of each acre reclaimed at Rs. 200, together with several times that amount as the estimated value of unskilled labour supplied free by the owner. The costs vary greatly according to the slope of the land and the depth of the drainage lines below the general level of the country". If the rupee is taken as worth Sh. 1/50, a cost per acre (exclusive of free unskilled labour) of Sh. 300 would be regarded as prohibitive in East Africa, where land values have not reached the fantastic levels common in parts of India. It must be remembered that this cost does not include the cost of actually levelling the land, which is put at Rs. 11 to Rs. 45 per acre including the services of 11 to 45 men per acre and the cost of their food and the use of 12 to 40 oxen.

In East Africa many soils would suffer from water-logging if fields were levelled off completely. In other areas the sub-soil exposed by this ruthless levelling would be practically useless for crop production for many years. Indeed in Hoshiapur, where the soil is a sandy loam, "When terraced, much of the top-soil is buried with the result that for the first year or two the crops are poor. It takes three to four years of cultivation and manuring to get the soil into first-class condition, when it produces very fine crops". It is probable, if many failures of structures occur, that they are not designed by an engineer who can make some intelligent estimate of probable flood flows. Indeed, Sir Harold Glover remarks: "The subject of correct drainage is now receiving the attention which it deserves in most districts, but a very great deal has to be learnt, as little is known as yet of this most important aspect of soil conservation". He also says that "It is essential that the fields shall be level and embanked and that the soil be properly consolidated: that the drainage of storm water shall be attended to. Works will not be complete when the machines have roughly terraced and levelled the land, as the power which water exerts will surely destroy the fields unless they are properly embanked and drained".

In the brief note on the Bombay Presidency Land Improvement Scheme by Mr. W. J. Jenkins, Director of Agriculture, Bombay Presidency, a system of erosion control on the gently sloping land of the lower slopes of the catchment areas is described. Contour bunds are made with minimum dimensions of 8 ft. base width, 3½ ft. high and 2 ft. top width in black cotton soil, and slightly smaller dimensions in soft and hard *murum* soils. The distance between bunds is not allowed to exceed a vertical interval of 6 ft. or a horizontal distance of 300 ft., whichever is the less. This distance apart on slopes less than 12 per cent would be considered far too much in Kenya, where average spacings laid down by engineers of the Soil Conservation Service for the Southern States in the U.S.A. are found very suitable. Greater distances apart encourage erosion between terraces and lead to silting of the channels. However, Mr. Jenkins adds that in actual practice the spacing between bunds is generally a vertical drop of 4 to 5 ft.; further experimental work is in progress to determine the optimum dimensions and spacing of contour bunds on different types of soil, slopes, etc., and a Research Section of the Land Improvement Section has been organized to carry out scientific investigation into the technical and economic aspects of bund construction. In this work in the Bombay Presidency no attention is paid to the boundaries of individual fields, but despite this fact cultivators have volunteered 700,000 acres of land to be bunded by the Land Improvement Section of the Agricultural Department.

It is hoped by Mr. Jenkins that contouring will lead to consolidation of holdings with contour bunds as field boundaries upon which to base the reallocation of land. The work is carried out by hand. Over 4,000 miles of contour bunds had been constructed at the time of writing, involving the movement of about 400 million cubic feet of earth. In August, 1943, during the Bijapur famine there were about 40,000 labourers engaged in bund construction. The cost per acre is stated to be about Rs. 12 (Sh. 18) per acre, including overhead charges. The intention is that landowners shall repay 75 per cent of the cost to Government, i.e. about Rs. 9 (Sh. 13/50) per acre. The Bombay Land Improvement Schemes Act, 1942, provides legal machinery to ensure repair and maintenance of anti-erosion works while there is provision for inclusion of land

of a recalcitrant minority within any scheme. The Land Improvement Section has agricultural staff to introduce and extend better farming methods on the bunded areas.

Administration and Co-operation

In the Punjab reliance is placed upon the principle of voluntary closure of eroded and deteriorated forest and grazing areas, backed up by the threat of compulsory closure, which is applied in fact with sufficient frequency to give the threat some potency. The villagers, according to this report, are reasonably susceptible to persuasion by Government officers, or in any case are convinced of the advantages of these measures, initially distasteful though they may be, when they receive the benefits of additional fodder, firewood or paid work in the forest areas. It must be admitted, however, that the Punjab men have some alternative possibilities of employment in industry (probably 150,000 men during the war), even though the Punjab is not as highly industrialized as some other parts of India; in the Army (there were one million fighting men from the Punjab, it is roughly estimated), in the Police and other public services. Remittances from soldiers make a considerable part of the income of certain districts.

However, when all is said there appears to be an amount of co-operative effort in the Punjab in the improvement and reclamation of land which East Africa would do well to emulate. Sir Harold Glover says "The remedies are easy to devise and frequently have been suggested . . . The difficulty is to give effect to these measures to induce the people to adopt them . . . . The first and greatest need is to get the people interested in the conservation of the soil, as in any case they have to do the work and reap its benefits, and this is accomplished by propaganda".

This aspect of land reclamation and rehabilitation in East Africa, as in all countries in which there is the problem of the regeneration of the agricultural industry and the rehabilitation of the land, is one of vital importance. Success depends on the degree to which co-operation and understanding of the new ways can be induced in the mass of the population, on the efficacy of the machinery for the necessary mass education in this direction. Even Russia did not rely on "the big stick" to secure the permanence of the rationalization of her agriculture—though, indeed, the disasters which occurred in the early days of "collectivization" were largely the result of insufficient effort to persuade an ignorant but stubborn and conservative peasantry as to the need for changes, in the interests of the defence of the nation. Compulsion is required is both the Punjab and East Africa on occasion. In certain directions, such as the closure of areas to grazing, it can have immediately beneficial and evident effects. Nevertheless, it is reported by Sir Harold Glover that there have been better results and less poaching on areas closed by groups of villagers voluntarily than on areas formally demarcated and closed by order of Government. It is even more difficult to enforce good husbandry on agricultural land. Neither soldiery, police, nor an army of inspectors, scouts or guards can enforce a number of ignorant, and often un-able-bodied peasants, to sow, to plough, to manure, to cultivate, to reap their crops according to the tenets of the best agricultural textbooks or advisers.

G. V. Jacks, in a recent Technical Communication of the Imperial Bureau of Soil Science on "Land Classification" remarks that "A unique feature of land-use planning is that the people not only make and execute the plan, but themselves constitute one of the chief things to be planned". He quotes Gross in the *Journal of Farm Economics* in 1943, who "in an analysis of the failure of the nation-wide county land-planning programme launched in the United States in 1938 by the Mount Weather Agreement, attributed failure in the first place to the fact that no desire to solve community and county problems was created in the population of the areas in which the planning programmes were to function. 'Experts can work out beautiful expositions of problems, they can present exclusively alternate solutions, but unless a self-interest to achieve these results is established, the expensive work of the expert has little or no value'. In Gross's opinion the prime task of the land planner is not to solve certain immediate problems, but to develop a community determination to solve them. It is a task which the experts in geography, agriculture, soils, economics and so on are not always qualified to perform. If county land planning recovers from its present demise the specialist in a future planning organization 'should be made cognizant of his purely advisory capacity'."

Such "community determination", it may be agreed, cannot necessarily be developed by specialists in agriculture, in soils, or economics. In any country ignorance and lethargy amongst the people are only likely to be vanquished in any measurable time and at any reasonable

cost by means of hand to hand combat, by a force of educators which will move amongst the people and lead them on the field; and the rank and file of the force in African countries must be Africans, men and women who are not so far removed from the people themselves that their words are apt to engender suspicion and antagonism. The importance of this principle has been stressed forcibly by Julian Huxley in his book "TVA" and by David E. Lilienthal, Chairman of the Tennessee Valley Authority in his book "TVA—Democracy on the March". The TVA small farmer had to be educated, just like the African —but imagination and great resources were bent to the task. In the Tennessee Valley "For a time these new ways of doing things were viewed with some suspicion. All kinds of rumours spread through the countryside. One story was that once a farmer put this TVA phosphate on his land, the land would henceforth belong to the Government". Doubtless, when Uganda phosphate is available for the native areas of Africa similar rumours will be spread! The enemy in Africa, the Tennessee Valley or the Punjab is not erosion, but one of its parents, ignorance.

The Registrar of Co-operative Societies in Kenya Colony recently deplored the apparent lack of desire of Kenya Africans to co-operate. A special Committee of the Fabian Colonial Bureau reporting on "Co-operation in the Colonies" observed "The greatest obstacle is the backwardness of the people and the lack of that indomitable spirit of self-help which will overcome all the difficulties" and "Until there is a better spirit, and until the African realizes that he cannot develop his country without a real effort on his own part, the more difficult forms of co-operative society must be introduced with caution, and then only after thorough preparation".

Encouraged and fostered by such men as Mr. C. F. Strickland and Brigadier F. L. Brayne, now Secretary to Government, Punjab, Development Department, as Lord Lugard said, "In North India the (co-operative) movement may be said to have assumed national proportions, with primary societies, district and provincial unions for policy supervision and audit, and district and provincial co-operative banks". It is to be feared that too much of the energies of Africans who should be leaders of their people in East Africa are diverted into political channels and the co-operative movement has yet to find any local champions from amongst the people which the movement is to serve. Strickland has stated, however, that the co-operative movement, which affords an admirable outlet for the energies of educated youths in assisting the social and economic betterment of their people, has in all countries held aloof from political movements—with one solitary exception in India, where a society decided to non-co-operate and so dissolved itself.

The small scale communal terracing efforts in the Punjab have already been mentioned. Similarly in East Africa communal efforts by clan or family groups in constructing narrow base contour terraces have been encouraged by the Department of Agriculture in some of the Kikuyu reserves and elsewhere. Sir Harold Glover mentions many co-operative societies formed for a variety of purposes in the Punjab, and in several instances the rules of these societies are given in his report. These societies have been encouraged by Forest Officers, by the Co-operative Department and by successive Indian Ministers of Development in the Punjab and include societies for such purposes as land reclamation, the management of village forests, the building of weirs and construction of *wattbundi*. In some parts of the country the people prefer, however, to manage their soil conservation affairs by means of a village committee or *panchayat*.

In view of the inadequacy of the labour and bullocks available for levelling and terracing land, Mr. Stainton, Deputy Commissioner, Rawalpindi District, proposed that with the assistance of Government a corps of disciplined demobilized soldiers should be raised which should be employed in land reclamation, with the use of machinery, under the direction of a society entitled Conservation and Reclamation of Land Society, Ltd. Sir Harold Glover details these proposals with model rules for such a society.

Conclusion

While actual details of soil conservation technique used in the Punjab are necessarily different from those usually required in East Africa, Sir Harold Glover's report has a great deal of interest for a large number of people in these territories. It might be hoped that some of the African intelligentsia might spare time from their more abstract political preoccupations to study the difficulties of preserving the land in Northern India where, as in East Africa, a rapidly rising population, subdivided and fragmented holdings—often of a minute size—overstocking and abuse of forests,

failure to prevent erosion and neglect of the practices of good husbandry is leading to malnutrition, insecurity and poverty. It is not understood that the Punjab peasantry any more than the illiterate (or many of the literate) Africans are readily susceptible to reason or willing to accept drastic changes in their economy. (It has been shown, however, that able-bodied men in the Punjab have some opportunity of seeking alternative occupation even if industry is not yet well developed in this state.)

The most hopeful sign is the development of co-operative effort to safeguard and develop the natural resources of the Punjab. On the other hand the high rate of population increase in these deteriorating lands is a most disquieting factor. In such circumstances there is a race between the spread of education and enlightenment against ignorance, deterioration, some of it irretrievable, poverty and the pressure of the chafing millions.

A few weeks ago I was buttonholed by Dr. Paterson, the former Director of Medical Services in Kenya Colony and sociological student in East Africa. He referred to the supposed rapid increase in population in Kenya Colony, which he stated has been greater during the past ten years than in India at its most prolific stage; and he asked whether I thought that the menace of this increase could be checked during the next twenty years by means of mass education of the people. I returned an unfavourable opinion. Conscious limitation of the birth rate only occurs when a people or a section of the population has living standards high enough to be worth safeguarding and educational standards to maintain. While a condition of poverty exists a larger family means at least more hands in the field, and, in East Africa, some future return from bride price payments or family subsidization by remittances from working sons which provides some sort of social security against old age. In such case there is no incentive to the limitation of families.

It is disappointing that there is no precise information, or indeed much detail at all, in the report under review regarding the living and nutritional standards of the Punjab peasantry to enable a comparison to be made with those of East African native farmers. The increasing population in the Punjab must threaten the success of the co-operative movements and all efforts made both to secure the land and improve the lot of the people. Neither in the Punjab nor in East Africa can land reclamation be regarded as a separate problem divorced from its sociological and general economic implications. It remains to be seen how the new Indian Government will deal with this—the problem not only of Punjab but of India—the balancing of the population with the land, with the industrial opportunities, with the food and available goods; and with the question of securing distribution of purchasing power amongst four hundred millions of people on a sub-continent on which there are five million more mouths to feed every year, five million more bodies to clothe, producing an increasingly explosive situation.

It remains to be seen, indeed, whether the Co-operative Societies will continue to work successfully, whether the forests will be safeguarded and improved during the next few years; or will hordes of cattle and goats return to the regenerating grasslands and forests, will the *chos* yet again pour floods of sand upon a developing desert in the Punjab, in which hunger and disease will stalk irresistibly?

A NOTE ON ALLANBLACKIA STUHLMANNII Engl.

By A. Glendon Hill, B.A., B.Agr., B.Sc., Director, East African Agricultural Research Institute

(*Received for publication on 5th February,* 1947)

Considerable interest has been shown in this tree from time to time as a source of edible fat. The tree, which belongs to the family *Guttiferæ*, occurs in great numbers in the evergreen forest of the East Usambara Mountains of Tanganyika between 1,500 and 4,000 feet above sea level, its distribution extending to the wet, eastern slopes of the West Usambara Mountains and then, by discontinuous distribution, to the Unguru and Uluguru Mountains to the south. It is one of the commonest trees in the Amani district of East Usambara where it is known in Kishambaa as Mshambo or Mwaka. This handsome, evergreen tree with glossy, lanceolate leaves and pink waxy flowers grows to a height of 60 to 100 feet. It has a much-branched, slender, columnar crown the end branches of which are pendulous. Its large, conical fruits have a brittle, russet-brown shell which is indehiscent. In the Usambaras its fruits are about one foot long and six inches in diameter and contain 20 to 28 seeds, or nuts, each of nine to twelve grammes. The nuts have a thin, brittle, reddish-brown shell which adheres closely to the kernel within from which it is not easily separated. The proportion of kernel in the nut is approximately 77 per cent. The trees appear to bear steady annual crops but no yield figures are available. The fruits mature in Usambara during the period November to January and when ripe fall to the ground where they smash, exposing their nuts held in a red-brown pulp. These nuts are easily picked from the pulp and if required for extraction should be sun-dried as soon as possible in

Longitudinal section through a fruit of *Allanblackia Stuhlmannii*

Photo by P. J. Greenway

order to keep down the free-fatty-acid content. Sun-dried nuts contain approximately 51 per cent of fat or 66 per cent of the kernel weight, equivalent to 71 per cent expressed on a moisture-free basis.

The fat can be extracted by reducing the dried nuts to a coarse meal which is then boiled in water for about six hours before been squeezed, while hot, in a screw-press. The yield of fat obtained by this method is about 30 per cent of the sun-dried nuts. The higher the yield obtained on pressing the higher the melting-point of the fat since the lower melting-point fractions come away first. The fat as extracted is white with a slight reddish tinge, almost odourless and without any pronounced taste. A sample of fat, extracted with light petroleum, examined at the Imperial Institute in 1929 had the following constants which are shown in comparison with figures previously obtained for the fat of Kisidwe nuts (*Allanblackia floridunda*) from the Gold Coast:—

	A. stuhlmannii fat	Kisidwe fat
Specific gravity at 100°–15°C.	0·8549	0·8563
Refractive Index at 40°C.	1·457	1·458
Melting point (open tube method)	40·0°C.	38·6°C.
Solidifying Point of fatty acids	60·0°C.	57·6°C.
Acid Value	9·9	1·0
Saponification value ..	189·6	190·8
Iodine value, per cent ..	39·6*	44·2†
Unsaponifiable matter, per cent	0·76	0·4

*Wijs, 3 hours. †Hübl, 18 hours.

The results of the above examination showed that *Allanblackia stuhlmannii* nuts yield a high percentage of a firm, white, somewhat brittle fat of high melting-point suitable for soap or candle making and, when refined, for edible purposes. During the Hitler war several small consignments of this fat were sent from Usambara to Kenya for use in chocolate manufacture, while during the Kaiser war the Germans in East Africa used the fat as a butter substitute during the blockade.

The following figures show that the residual meal left after the extraction of the fat contains a reasonable percentage of proteins. This meal, however, would probably be unsuitable for cattle because of a small amount of tannin which is present. No alkaloid or cyanogenetic glucosides were found in the meal:—

	A. stuhlmannii meal (containing 7 % fat)	Kisidwe meal (containing 7 % fat
	Per cent	*Per cent*
Moisture	13·1	9·3
Crude Proteins ..	14·0	16·4
Fat	7·0	7·0
Carbohydrates ..	55·3	52·2
Crude Fibre	7·3	8·9
Ash	3·3	6·2

It seems doubtful whether it would ever be profitable to establish plantations of *Allanblackia stuhlmannii* but, given the right soil and environment, there is no obvious reason why this should not be done, should the occasion ever arise, since the tree is hardy and readily propagates itself from seed. It should be possible in normal times to obtain considerable quantities of nuts from the wild trees of the Usambara forests by paying the collectors about five cents (East African) per kilogramme for them.

REFERENCES

Greenway, P. J. (1934).—Oil-bearing Nuts: in pp. of E.A.A.R.I., Amani.

Jamieson, G. S.—Vegetable Fats and Oils, N. York, 1932.

Imp. Inst. Report 0.2059 of 4-10-29.

Worsley, R. R. Le G.— In pp. of E.A.A.R.I., Amani.

THE CULTIVATION OF RICE LAND BETWEEN SUCCESSIVE CROPS

By G. E. Tidbury, Agricultural Officer, Zanzibar

(*Received for publication on* 10*th December*, 1946)

This experiment was originally suggested by Mr. J. C. Muir, O.B.E., at that time Director of Agriculture in Zanzibar. Mr. A. K. Briant and Mr. F. B. Wilson, M.B.E., Agricultural Officers, have been in charge of certain of the experimental blocks for part of the duration of the trial, and the writer gratefully acknowledges these officers' share in the investigation.

Although rice has always been the staple food in Zanzibar and paddy cultivation is carried on annually by a small number of the country people, it was not until 1942 that large scale cultivation of rice by nearly the entire rural population became general throughout the Protectorate. This rapid and very widespread increase in the rice crop was caused by the loss of Burma, a country from which Zanzibar normally purchased her entire rice needs as part of a cash crop economy resulting from intensive clove production. With the increased acreage and the limited extent of land suitable for rice, which made adequate fallowing impracticable, it was feared that some reduction in fertility and a decrease in yields over a number of years would be unavoidable, especially on the open plains where the bulk of the rice is grown on relatively infertile soils.

The treatment of the land between successive crops of rice obviously has a considerable effect on its fertility, and a need was felt for a further knowledge on this aspect of rice cultivation, particularly as the production of another food crop between the rice crops would be a most valuable means of increasing food supplies, provided that this would not further reduce fertility. This article records results of an experiment conducted in Zanzibar for four years in order to elucidate some of the effects of the various common cultivation practices seen in the Protectorate, and their possible effects on each other.

Rice Cultivation in Zanzibar

A previous article by Mr. F. B. Wilson, M.B.E., and the present writer (*East African Agricultural Journal*, Vol. IX 4, April, 1944) described the method of paddy cultivation in Zanzibar in detail. Pemba practices differ very little from those of Zanzibar Island, except that the growing season in Pemba is approximately one month later than in Zanzibar. The hill rice cultivations of Pemba were not included in this investigation.

The chief rice areas are either the flat sandy plains of the eastern sides of the islands, on which an almost impervious clay subsoil causes a high water table and even waterlogging in the wet season, or the rich loams of the valley bottoms between uplands carrying clove plantations. Rainfall varies considerably throughout the Protectorate from nearly 100 inches annually in parts of Pemba to 60 inches in the western side of Zanzibar, even less being received in the eastern regions of both islands. The hot, dry weather of December and January enables cleaning and cultivation to be undertaken and after the preparation of a fine seed bed the earliest showers of the *masika* or main rains allow the seeds to be broadcast in January, February, or early March. After a period of slow growth the heavy rains of April and May, or even June in Pemba, support the full growth of the crop. Rice is harvested in July and August and usually a tall stubble, which results from the common method of harvesting only the ears of the grain, is left standing.

After the rice has been harvested the soil is still damp and easily worked, and a large proportion of the available land is planted either to pulses, such as cowpeas and gram, or to root crops. These crops may either be planted on the ridge or on the flat. In Pemba the system is varied usually by a period of stubble grazing by cattle between August and November, after which the pulses are planted in the short or *vuli* rains.

This trial was designed to investigate the effects of four common cultural practices connected with this rotation, which are as follows:—

1. The usual way of dealing with the stubble remaining from the rice crop is to burn it. Information was needed as to whether this was the best method of disposing of crop residues or whether the straw would best be turned in to rot under the succeeding pulse crop.

2. The value of ridging the intercrop was to be assessed. Such information as was

available on this subject indicated that ridging alone might be beneficial through soil aeration and weed suppression.

3. The direct effect of a pulse crop on the main rice crops was to be determined apart from its own value as a food crop. In the first two years of the experiment the leguminous crop grown was Florida velvet bean (*Mucuna deeringiana*), as it was thought that the heavy growth usually obtained from this crop would show more clearly the effect of the legume. In the two last seasons, however, cowpeas were grown because members of the public seeing the experiments would appreciate better the value of this treatment. Cowpeas actually produced quite as heavy a growth as the Florida velvet bean and in the results of the experiment given below the term "pulse" is meant to indicate either crop. No attempt was made in this work to assess the value or otherwise of root planting between rice crops, as this is being undertaken in a separate trial.

4. Before preparing the fields for rice again, the common practice is to burn the weeds and crop residues during the dry season. It was considered that a more valuable way might be to compost these residues and apply the compost to the rice crop. This would take the form of removing the vegetative cover from the flat areas and composting it separately under cover near the rice field, or in the case of the ridged land to split the ridges and bury the trash, thus composting in situ.

These four factors might also depend to some extent on each other for their effect, so the experiment was designed to elucidate any possible interactions between the four treatments, thus providing sixteen combinations in all to be tested.

Experimental Lay-out and Procedure

In order to accommodate the areas to be ridged in large blocks so that this treatment could be carried out effectively, the simple 2 by 4 factorial layout was not adopted but a split plot design was utilized in which the main plots were either ridged or flat and the other treatments randomized upon them in a 2 by 3 factorial arrangement. It was realized at the outset that this arrangement would provide very few degrees of freedom for error in the upper part of the table of analysis, and so make significant results difficult to obtain for the ridging treatment, but it was felt that ridging was the most likely treatment to show results and the cultivation of large 5 ft. ridges in small plots was impracticable.

The five blocks were not contiguous, but were placed in various parts of the islands in order to utilize the work both as an experiment and as a demonstration to the public. This proved to be unwise, as the less successful treatments were not suitable as demonstrations and the increased variability caused by separation of the blocks markedly reduced the number of responses which subsequently proved to be statistically significant.

Each plot was 1/50th acre in size and, except for one year in which equal weights of seed were broadcast over each plot, the rice was transplanted from a seedbed spaced at 6 in. by 6 in. This reduced error by giving a uniform plant.

An obvious and unsightly effect of the ridging treatment was observable in the subsequent rice crop, which grew irregularly with a corrugated appearance. This was due to the plants situated between the previous banks growing much more luxuriantly than those situated where the crests of the ridges had been. This effect was reduced to small proportions by a deep cultivation to avoid the hard core of the ridge being left unturned and by making the ridges each year at right angles to the direction used in the previous year.

Results

The results were partly spoiled by great variability, which was to a large extent caused by misfortune. In the first year one of the blocks had to be discarded owing to a neighbour harvesting part of the experimental area; in 1944 a plague of army worms, *Laphygma* sp., invaded two blocks and caused a serious setback to the growth of the crop; and in the last year of the trial, drought conditions which were worse than had been known in Zanzibar for many years and which caused the rice crop in Zanzibar to fail almost completely and that in Pemba to provide less than half the expected crop, reduced the yields on three of the blocks to extremely small proportions.

Harvest yields were as follows, each figure representing lb. of paddy from five plots each of 1/50th acre:—

TABLE I

	1943	1944	1945	1946
RIDGED PLOTS				
1. Stubble unburnt, no pulse, trash burnt	63·8	119·0	89·2	42·4
2. Stubble burnt, no pulse, trash burnt	65·4	111·3	109·3	32·1
3. Stubble unburnt, pulse crop, trash burnt	61·5	122·3	124·1	46·2
4. Stubble burnt, pulse crop, trash burnt	61·5	122·3	124·1	46·2
5. Stubble unburnt, no pulse, trash composted ..	61·7	105·8	116·3	37·5
6. Stubble burnt, no pulse, trash composted ..	79·1	104·3	117·1	50·7
7. Stubble unburnt, pulse crop, trash composted ..	68·7	104·3	113·0	25·0
8. Stubble burnt, pulse crop, trash composted ..	85·9	119·5	167·3	62·2
FLAT PLOTS				
1. Stubble unburnt, no pulse, trash burnt	56·2	97·8	101·3	34·9
2. Stubble burnt, no pulse, trash burnt	53·9	113·8	115·3	23·3
3. Stubble unburnt, pulse crop, trash burnt	62·0	100·0	107·5	38·3
4. Stubble burnt, pulse crop, trash burnt	66·6	102·3	107·2	29·7
5. Stubble unburnt, no pulse, trash composted ..	40·4	71·3	101·8	21·0
6. Stubble burnt, no pulse, trash composted ..	35·2	67·5	78·2	14·6
7. Stubble unburnt, pulse crop, trash composted ..	60·7	96·0	104·6	23·6
8. Stubble burnt, pulse crop, trash composted ..	58·6	109·0	94·4	21·3

Analysis of these figures gave the following results:—

TABLE II

	Lb. paddy per acre of succeeding rice crop			
	1943	1944	1945	1946
RIDGING TREATMENT				
Flat..	542·0	947·5	1012·9	200·0
Ridged	639·1	1127·5	1199·5	258·4
Increase due to ridging	27·9%	19·0%	18·4%	29·2%

The increases due to ridging the intercrop are not statistically significant. Nevertheless, it is felt that there is a strong indication that ridging the land into large 5 ft. banks between the rice crops does lead to an increased yield of rice.

The responses to the other treatments and to the interactions between them, in lb. of paddy per acre, are as follows:—

TABLE III

	1943	1944	1945	1946
OTHER TREATMENTS				
1. Stubble burning	30	51	70	37
2. Pulse Planting ..	96	99	141*	24
3. Interaction between stubble burning and pulse planting	2	44	42	75
4. Composting the trash	–9	–131*	19	–24
5. Interaction between stubble burning and composting	38	9	17	67
6. Interaction between pulse planting and composting	48	101	24	–1
7. Triple interaction	6	41	126*	–5
Level required for significance at P=0·05	99	122	113	96

STUBBLE BURNING

The disposal of the rice straw by burning as compared with turning it into the land caused no statistically significant increases in yield. The responses to this treatment each year, however, were always positive and it may be said that at least no fertility is lost by this procedure.

An interesting relationship is disclosed, however, when the interactions between the main ridging treatments and the other treatments are analysed. This was done by expressing the responses to the factorially arranged "other treatments" in the usual way, but separately for the flat and the ridged plots. The differences between the separate responses then indicate interactions with the ridging treatments. This is shown for the 1945 harvest yields in the following table:—

TABLE IV

	Responses, lb. per acre		
	Flat	Ridged	Difference
TREATMENT			
1. Stubble burning ..	–25	95	120*
2. Pulse planting ..	21	120	99
3. Interaction between stubble burning and pulse planting ..	–1	43	44
4. Composting trash ..	–65	84	149†
5. Interaction between stubble burning and composting	–60	43	103
6. Interaction between pulse planting and composting ..	27	–3	30
7. Triple interaction ..	35	91	56
Differences required for significance—			
P=0·01	—	—	149
P=0·05	—	—	113

These figures therefore indicate that stubble burning is apparently a useful method of dealing with the straw when the burning is followed by ridging. If this is indeed the case the reason is obscure.

Pulse Planting

Pulse planting between crops of rice undoubtedly causes increases in the rice crop. Increases in the yield of paddy as great as 141 lb. per acre are attributable to the intercrop. This increase was statistically significant in 1945 and in the analysis of the combined yields of 1944 and 1945 significance at P = 0.01 was obtained.

That the valuable effects of pulse planting are obtained mainly when it is planted on ridges is indicated by the table of interactions, Table IV, shown in the previous paragraph. Here the increased yield due to pulse planting was calculated at 120 lb. per acre on ridged land and 21 lb. per acre on the flat.

Composting the Trash

The responses to composting the trash before planting the next crop of rice are somewhat surprising as they are usually negative, significantly so in 1944, when a decrease in the yield of the subsequent rice crop of 131 lb. paddy per acre was observed. The explanation of this apparent evidence in favour of burning the trash before preparing the land for rice is to be found in the table of interactions, Table IV, where the composting treatment causes a positive response on the ridged land and a negative one on the flat. This was also observable significantly in 1943 when composting on the flat half-blocks led to a negative response of 55 lb. per acre, and on the ridged area to a positive response of 45 lb. per acre of paddy.

The reasons for this are appreciable agriculturally. On the flat land growth of the intercrop, whether pulse or weed, was poor in comparison with the ridges. Moreover, the trash was actually removed from the land and composted in a separate heap. When returned to the appropriate plots in the following year the small bulk of compost had little effect in increasing the rice yield, less in fact than the depressing effect of removing the vegetative matter from the land. On the other hand, on the ridged land, where composting was done in situ by splitting the ridges over the trash, the effects on the subsequent crop of rice were beneficial, although not so great in one year as to outweigh the negative effects seen on the flat land.

Interactions Between the Treatments

The only significant interaction is the response to the triple interaction observed in 1945. This is difficult to appreciate agriculturally except to remark that the combination between stubble burning, pulse planting and composting in situ appears to be a suitable one to the needs of the rice crop.

Another interesting interaction that emerges, although not significantly so, is that there is some indication that the composting treatment is more valuable if the composted material is the pulse trash (Table III). This is to be expected, as the nitrogen content is presumably higher than that of weeds.

In considering the experiment as a whole it is noteworthy that until the severe drought of 1946 the yields increased steadily thus: 1943, 618 lb. per acre; 1944, 1,037 lb. per acre; 1945, 1,106 lb. per acre. There is therefore reason to suppose that the fertility was at least not being depleted.

The ridging treatment had other advantages apart from increasing yield, which were manifest when the cultivations on the field were done. By the end of the rice harvest the fields were always overgrown with annual weeds already in flower. Ridging effectively destroyed these weeds, which seeded freely on the flat land. Secondly, the work of preparing the land for rice was much easier on the ridged blocks as it only involved splitting the ridges, a far easier task than turning land which had not been dug over for a twelvemonth. Less time was taken even when the cores of the ridges were carefully broken, and this is a matter of importance as adequate time for cultivation may not be available in a year of early rains. Although the costs of these operations is not an important factor for the peasant cultivator, it was clear that provided the pulse crop paid for its own cultivation the method of ridging was cheaper than leaving the land flat.

Summary

An experiment is described which was conducted in Zanzibar to determine the best methods of dealing with rice land between successive crops of rice. Results and observations indicate that increased yields of rice are obtained if after harvest the stubble is burnt, the land thrown up into large ridges, and then planted with a pulse crop such as cowpeas. Removal of the weed or pulse trash for composting off the field, the compost being applied later to the rice crop, reduced yields.

YEHEB

By P. J. Greenway, Systematic Botanist, E.A.A.R. Institute, Amani, and W. D. Raymond, Government Chemist, Tanganyika

(*Received for publication on 14th February, 1947*)

Yeheb, or to use other variants, *Yebb*, or *Yeeb*, is a seed eaten by the Somalis and is obtained from the pods of *Cordeauxia edulis* Hemsl., a dwarf shrub of the Amherstieæ in the Caesalpiniaceæ which is restricted to Somaliland and south-eastern Ethiopia. Its existence appears to have been first recorded by the Italian Robecchi when traversing Somaliland from Obbia to Bari in 1871, when he met with it twice and records its name *Jiebb* in the first instance and again as *Jieheb Gud* or *Guda*.

It was next recorded by Capt. M. S. Wellby in his *Report of a Journey in Somaliland* in 1895. It was not till ten years later that a sample of seeds under the name *Yebb* nuts was forwarded to the Imperial Institute by Col. E. J. E. Swayne, C.B., one time H.M. Commissioner, Somaliland Protectorate, for determination of their nutritive value.

A further consignment from the same source was sent to the Imperial Institute at a later date. Some of the seeds from this were sent in March, 1906, to Professor H. Church, F.R.S., who took them to the Royal Botanic Gardens, Kew, for identification. Their identity could not be established with this material and some of the seeds were sown and two small plants were grown from this seed.

Attempts to obtain botanical specimens from Somaliland at first were not successful, and it was not until July, 1907, through the efforts of Capt. H. E. S. Cordeaux, C.B., H.M. Commissioner, Somaliland Protectorate, that botanical specimens were obtained which enabled the Kew authorities to establish its identity. It proved to be a leguminous plant belonging to a hitherto unknown genus in the Caesalpiniaceæ, closely related but very distinct from the genus *Schotia*. The latter genus contains eight species of which five are recorded from the Belgian Congo and a sixth from Southern Rhodesia.

A description of the plant was drawn up by W. B. Hemsly and it was given the generic name *Cordeauxia*, in compliment to Capt. Cordeaux, with the specific epithet *edulis*. Capt. Cordeaux described the *Yebb* or *Yeheb* as a small bush which grows in great quantities in the "Haud" or waterless desert south of Bohotleh and of the southern frontiers of the Protectorate, and states that "the seeds form the staple article of food of the poorer classes of natives living in the 'Haud' and for the most part consumed as they are collected. Small quantities of the nuts, however, find their way amongst the northern tribes and even as far south as the coast towns, where they are eagerly bought by the Somalis, who have great faith in their nutrient and medicinal properties, often preferring them to their usual dietary of rice and dates. The bush is said to seed itself readily and grows with great rapidity".

Mr. G. G. Gilligan, who was stationed for some time in British Somaliland, stated that the tree begins to fruit when it is about 5 ft. high and that it "often grows into a large tree". According to him it bears profusely in good seasons, and the seeds, which are very nourishing, are usually boiled or stewed, although they may be cooked in other ways. The water in which the seeds have been boiled is sweet, and is sometimes drunk by the Somalis.

The *Yebb*, *Yeeb* or *Yeheb* is a small, much branched, bushy shrub about 2 ft. tall, not unlike birch-broom in shape, with roots about 6 ft. long according to Capt. Cordeaux's Somali informant. Capt. Wellby, who first observed it in its native habitat, described it as a "small, thick-leaved bush, always green, with a nut enclosed in a thin, crisp shell and eaten stewed. If the green leaves are rubbed in the hands they are stained red". Its compound leaves are pinnate, arranged alternatively on the erect branches which are of very hard wood. The leaflets are usually in four pairs, the blade oval-oblong in outline, leathery, and covered densely below with red, scale-like glands as are the sepals and young fruits. The flowers are few, arranged in corymbs at the apices of the branches, and their sepals, of which there are five, are oblong with slightly pointed tips. The five petals are subequal, spoon-shaped, with a narrow stalk or claw at the base and there are ten free stamens whose filaments are hairy at the base. The ovary is shortly stalked with a terminal obtuse stigma, and contains one to two ovules. The fruit is a leathery, compressed ovoid,

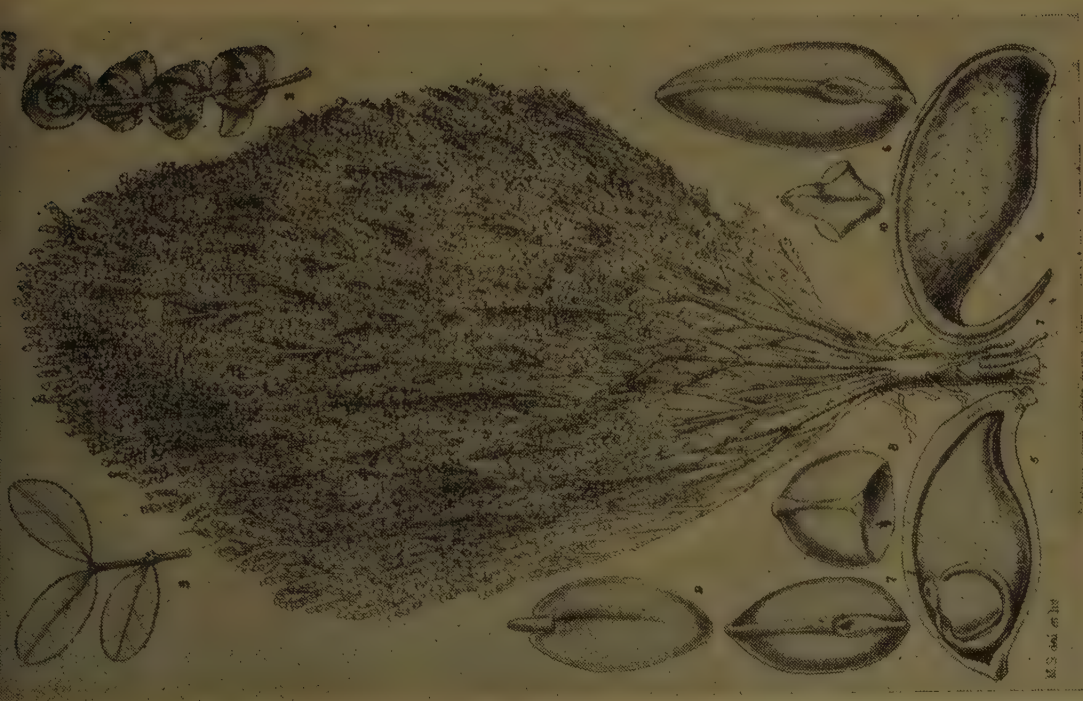


PLATE I

PLATE II

Reproduced from "Hooker's Icones Plantarum" by kind permission of The Bentham Trustees, London

curved pod with a beaked apex, dehiscent, two-valved, containing usually one but sometimes two ovoid exalbuminous seeds. (*See* plates 1 and 2.)

Besides Capt. Cordeaux's specimens collected in the desert south of Bohotleh, others have been collected by Drake-Brockman near Behra, near Galkayya, and the Italians G. Zaccarini and R. Meregazzi record it as forming 50 per cent of the local shrub-like vegetation in a belt northwards of the Uebi Seebeli. The plant is represented in the Amani Institute Herbarium by specimens collected by Major P. E. Glover, M.B.E., who also sent to Amani several consignments of fruits and seeds which have been distributed to Kew, South Africa, Jamaica and the United States for cultivation.

Its main area of distribution appears to be from Long. 44° to about 49° E. and Lat. 40° 38′ to about 9° N., this covers the southern border of British Somaliland (westwards of Bohotleh there is a place named Yeb on many maps), a greater portion of the eastern Ogaden, Ethiopia, and the central and northern sections of Italian Somaliland.

Major Glover's material was collected in the Las Anod and Wadere districts, where the habitat is a bushland of *Commiphora-Acacia* spp. of the Haud on a soil that "is the usual red sandy soil overlying limestone" at an altitude between 1,500 and 2,500 ft. with a rainfall between 6 and 8 in. a year. Major Glover reports that "all the *Yeeb* nuts sold in the towns are placed over a fire shortly after they have been picked to harden them up". This pre-treatment is probably necessary to keep the seeds from being attacked by boring beetles, because the fresh material of both seeds and pods was heavily infected by borers by the time it reached Amani. Major Glover also records that the bark and leaves yield a fairly powerful magenta stain used by the local inhabitants. Each small bush yields from the outer branches, which are easy of access, approximately ½ lb. of pulverized leaves, and these when boiled yield enough dye for ten yards of 36 in. wide calico or cotton cloth. The leaves are also infused to make a tea.

Analysis of the Seeds

An analysis of *Yeheb* seeds by the Imperial Institute gave the following results:—

	per cent
Moisture	9.3
Ash	3.1
Sugars—	
Reducing	2.3
Sucrose	21.6
Carbohydrates other than sugars, by difference	37.1
Proteids—	
Albuminoids	11.8
Amides	1.3
Fibre	2.7
Oil	10.8
Nutrient ratio	1:6.5
Nutrient value	92 gm. cal.

The seeds were tested for alkaloids and glucosides, but no indication of the presence of such constituents was obtained.

A sample of pre-heated seed obtained through Major Glover was sent to the Chemical Laboratory, Dar es Salaam, for examination with the following results*:—

Average weight of nut (including shell)—1.6 grams.

Average percentage of edible portion—69 per cent.

Average percentage of waste—31 per cent.

Alcohol insoluble matter—57 grams per 100 grams.

Made up of:—

	per cent
Starch	41.5
Protein	13.7
Roughage	1.8
(Fibre as determined—1.6 per cent)	
Sugar calculated as invert sugar, but present in the form of sucrose	12.4
Moisture	14.3
Ash	2.9
Fat (ether extract)	12.0
Total ..	98.6

The ash is made up of:—

	mgs. per 100 grams of edible portion
Calcium	29.6
Magnesium	75.3
Iron	2.3
Sodium	74.5
Potassium	1,211
Phosphorus	250
Chlorine	19.6

The seeds do not contain any large amount of carotene, and the vitamins of the "B" group and vitamin "C" have not been estimated.

* We are grateful for the assistance of Mr. E. Khomo in the analyses.

The Imperial Institute in their report say that the seeds are likely to prove a useful food stuff. "A satisfactory point is the presence of considerable quantities of sugars and oil in addition to the carbohydrates".

As a matter of interest, *Yeheb* nuts are compared below with other foods eaten by the Somalis and with three legumes that form important items in the dietary of the East African natives:—

So far attempts to grow *Yeheb* in other countries have not been successful. It is undoubtedly an important item in season in the dietary of the Somalis, but when more nutritious food crops are available there does not seem much purpose or profit in trying to establish *Yeheb* outside its natural habitat, especially in those countries where the annual rainfall exceeds 10 in. and the climate is not hot and dry.

	Moisture	Protein	Fat	Carbohydrate	Calcium mgs. per 100 gms.	Iron mgs. per 100 gms.
	Per cent	*Per cent*	*Per cent*	*Per cent*		
Yeheb (Imp. Inst.)	9·3	13·1	10·8	36·1	—	—
Yeheb (Dar es Salaam) ..	14·3	13·7	12·0	41·5	29·6	2·3
Dates (dried)	15–23	2	—	69	70	2
Rice	10–16	8	2	76	10	2
Kaffir-corn (Sorghum, whole seed)	8–14	10·4	3·4	70·9	32	6·6
Legumes :						
Cowpea (*Vigna ungiculata*)	8–14	24	1	44	90	4
Kidney Bean (*Phaseolus vulgaris*)	8–15	24	2	48	110	8
Bonavista Bean (*Dolichos lablab*)	7–10	24	1	55	60	2

Yeheb is low in protein and calcium and to a certain extent in iron, medium in carbohydrate and high in fat. The main characteristic of the seeds is their high sugar content. It is possible that the nut might find some application in the confectionery trade, since its very smooth consistency somewhat recalls the cashew nut, which also contains a certain amount of sugar. The only advantage it appears to have over the three legumes seems to be its fat content.

REFERENCES

Bull. Imp. Inst. 5: 19-20 (1907).
— 6: 207-208 (1908).
Kew Bull. 1907, p. 361.
Hooker's Icones Plantarum Tabs. 2838 and 2839 (1907).
Kew Bull. 1908, pp. 36-44 and 141.
— 1910, pp. 398-400.
Chiovenda, E. Flora Somala, pp. 156-158 (1929).
Barker, E. G.—The leguminosæ of Tropical Africa, 3: 620 and 621 (1920).
Platt, B. S.—Tables of Representative Values of Foods Commonly Used in Tropical Countries, Med. Res. Council Sp. Rep. Ser. 253 pp. 8-9; 14-15 and 24-25 (1945).

NOTES ON ANIMAL DISEASES*

III—PIROPLASMOSIS AND ANAPLASMOSIS OF ANIMALS OTHER THAN CATTLE, AND TRYPANOSOMIASIS OF DOMESTICATED ANIMALS

Compiled by the Department of Veterinary Services, Kenya Colony

PIROPLASMOSIS OF EQUINES (BILIARY FEVER)

Two species of piroplasms, both of which occur in Kenya, are known to occur in equines. They are *Babesia caballi* and *Nuttalia equi*.

Microscopically, *Babesia caballi* closely resembles *Babesia bigeminum* of cattle in appearance, whereas *Nuttalia equi* is a smaller parasite, more akin to the species of the genus *Theileria*. The latter parasite is much more frequently encountered in Kenya.

Both parasites are tick-transmitted. Transmission of *Nuttalia equi* to susceptible horses by adult *Rhipicephalus evertsi*, that had fed during the larval and nymphal stages on carrier animals, was demonstrated by Theiler in 1905, and it is probable that other ticks may also be capable of transmitting infection. Experimental transmission of *Babesia caballi* by African species of ticks has not yet been effected.

Susceptible donkeys and mules may be infected with *Nuttalia equi* by the inoculation of blood from infected horses; but clinical infections in these animals are rarely observed.

Symptoms.—After experimental inoculation the incubation period in *Nuttalia equi* infection is from seven to nine days. After natural infection the incubation period may be as long as three weeks. In general the symptoms and post-mortem lesions produced by the two parasites are similar. However, with *Babesia caballi* a continuous temperature curve occurs, whereas with *Nuttalia equi* the fever is of the intermittent type.

The first visible sign of sickness is usually a pale yellow coloration of the mucous membranes of the eyes and mouth. Later, in severe cases, small hæmorrhagic points occur in the third eyelid. The animal appears dull and shows lack of interest in its food, while its thirst is increased. During the early stages there is marked constipation, but later colicky pains and diarrhœa may be observed. The urine is usually increased in amount and yellow or reddish-brown in colour. Redwater occurs in rare cases; probably more frequently in severe *Babesia caballi* infection than in *Nuttalia equi* infection. Loss of condition is usually noticeable and in certain cases œdematous swellings of the limbs and sheath are present. Death may occur within four or five days of the onset of symptoms, or may be delayed for several weeks.

Post-mortem Lesions.—On post-mortem examination the most obvious abnormality noticed is a general jaundice of the tissues. The blood is thin, pale and watery, the spleen swollen, and other lesions analogous to those observed in redwater in cattle are usually found.

Immunity.—Recovery from an attack of biliary fever leads to the development of a state of premunity in every way similar to that following recovery from redwater in cattle. The disease caused by *Nuttali equi* is generally regarded as more severe than that caused by *Babesia caballi*.

Treatment.—Careful nursing and the control of constipation by the use of laxatives and enemata should form the foundations of treatment. Until quite recently direct specific therapy was not on a very satisfactory footing. Trypanblue may have been of some value in the treatment of *Babesia caballi* infection, but had little or no action on the commoner parasite. Quinine hydrobromide, 1 grm. in 20 c.c. sterile water given intramuscularly once a day for three days, was commonly employed in *Nuttalia* infections. However, within the last few years the use of Acaprin, introduced by Messrs. Bayer, has proved so successful that this drug has now superseded the older methods of treatment.

PIROPLASMOSIS OF PIGS

Infection of pigs by *Babesia trautmanni*, a parasite first described from pigs in the Kondoa-Irangi district of Tanganyika, has been observed but once in Kenya. The main symptoms are jaundice and redwater. The pathogenicity of the parasite appears to be low.

PIROPLASMOSIS OF DOGS (TICK FEVER)

Tick fever is most frequently seen in puppies, newly imported dogs and highly bred dogs. Dogs bred in East Africa usually contract infection early in life and recovery leads to premunization. More frequently than in redwater, however, the blood of a recovered animal will

* A revised edition of an article published in this Journal, Vol. 4 (May, 1939).—*Editor.*

fail to transmit infection to susceptible puppies. The causal parasite, *Babesia canis*, is similar in appearance to *Babesia bigeminum* of cattle; but the infection of one blood cell with more than one pair of parasites, frequently seen in tick-fever smears, is most unusual in redwater. In Kenya the usual transmitting ticks are *Hœmaphysalis leachi* and *Rhipicephalus sanguineus*. In the case of the former species, only the adults are capable of causing infection. Infection is passed through the egg, but neither larvæ nor nymphæ transmit the parasite while feeding. In *Rhipicephalus sanguineus* infection is also hereditary. In this case, however, while the larvæ of an infected female are non-infective, both nymphæ and adults will transmit the disease if fed on a susceptible dog.

Symptoms.—After an incubation period of from four to six days in dogs inoculated with blood or of ten to twenty-one days following the bite of an infective tick, the first indication of illness is a rise in temperature. Within a day or so, dullness, loss of appetite, and an increased desire to sleep are usually noticed. Anæmia is manifested by pallor of the eye membranes and the gums. Constipation is present, the tongue is furred, breathing becomes increased in frequency and the pulse weak and fast. Later the appetite is completely lost and the dog becomes progressively weaker and weaker. Jaundice is often observed; but whilst the urine may be brownish-green in colour owing to the presence of bile pigments, true hæmoglobinuria rarely, if ever, occurs. In acute cases death may occur three to ten days after the beginning of the temperature reaction.

Chronic cases in which the temperature reaction is slight or intermittent are not uncommon in puppies. In dogs so affected there is a progressively increasing anæmia. The animal is listless and its appetite capricious. Condition is rapidly lost. A percentage of these cases develop ascites, that is to say, fluid accumulates in the abdominal cavity, and, even if removed, usually the fluid collects again rapidly. Such cases do not respond to treatment and almost invariably end fatally.

Treatment.—Several drugs are available for the specific treatment of tick fever—trypan-blue, Acaprin, Pirevan, Piroparv, and Phenamidine. Whichever is chosen, the administration should not be delayed too long. The dog should be weighed and the proper dose calculated carefully. Specific treatment should be accompanied by suitable symptomatic treatment. The patient should be given a warm bed and kept quiet for at least forty-eight hours after the injection. During this period the occasional administration of a little brandy and milk is often helpful, particularly in cases where the pulse is very fast and weak. During convalescence, which should be rigorously enforced, tonics such as Parrish's food or Stovarsol are of value. Exposure to cold and wet should be avoided.

Relapses may occur seven to ten days after treatment. When the patient is properly nursed, specific treatment is usually unnecessary; but if the dog develops a high temperature and goes off his food specific treatment must be repeated.

Piroplasmosis and Anaplasmosis of Sheep and Goats

Small piroplasms are occasionally seen in blood smears from sheep in Kenya. They do not appear to be of importance.

Anaplasmosis is also seen occasionally in sheep and goats. Apart from a rise in temperature the reaction is usually symptomless.

Trypanosomiasis

All species of domesticated mammals are susceptible to one or more forms of trypanosomiasis. This disease, usually called "fly", is caused by one of a number of species of trypanosome, unicellular animal parasites which infect the blood and tissues of the host. These parasites differ from piroplasms and anaplasms in that they occur free in the blood plasma and do not invade the cells.

All the pathogenic species of trypanosomes in East Africa are transmitted by the bites of flies. The parasites responsible for dourine, a disease of equines recorded from North and South Africa, as well as from other parts of the world, are transmitted from the mare to the stallion and vice versa at service.

The species of pathogenic trypanosomes that have been recorded from Kenya are *Trypanosoma brucei*, *T. vivax*, *T. congolense*, and *T. evansi*. The first three of these are transmitted mainly by tsetse-fly, although it has been shown that on occasion other biting flies (for example, the widely distributed species of *Stomoxys*) may be responsible for mechanical transmission once infected cattle are introduced into a clean area. The disease caused by these species of trypanosomes, usually called "nagana", is, however, rarely of economic importance except in fly belts and adjacent areas. The species of tsetse of major importance so far as animal trypanosomiasis is concerned in

East Africa is *Glossina pallidipes*, but other species of the genus *Glossina* are potential transmitters of these parasites. *Trypanosoma evansi*, the cause of surra, is transmitted by tabanid flies and possibly by *Ornithodoros* ticks.

Fly belts in East Africa are rarely clearly demarcated areas. Under certain climatic conditions tsetse-flies, in particular *Glossina pallidipes*, show a tendency to migrate from their habitual breeding grounds and to occupy temporarily new territory. This process is known as dispersal, and accounts for outbreaks of fly in areas adjacent to, but not usually considered as parts of, recognized fly belts. Sporadic cases of fly may be caused by tsetse that have been carried from their usual haunts by motor cars, railway carriages, or other vehicles, or that have followed herds of game on migration.

Surra in East Africa is mainly a disease of camels, and in Kenya is restricted to parts of the Northern Frontier District and to the coastal belt.

Whilst the train of symptoms produced by the different species of trypanosomes in East Africa is generally similar, the species vary in their pathogenicity for the different domesticated animals. It is important to note also that various strains of each species are recognized that differ amongst themselves in pathogenicity.

Trypanosoma congolense is probably the commonest species causing nagana in cattle. In addition, strains of this species are usually highly pathogenic for dogs and pigs. Sheep, goats, and equines are somewhat less susceptible. As a parasite of cattle, *Trypanosoma vivax* is next in importance in Kenya. Sheep and goats may also be found infected, but horses are relatively insusceptible and dogs are resistant. *Trypanosoma brucei*, on the other hand, is highly pathogenic for horses, camels, dogs and pigs. Cattle, sheep and goats, although they react to the extent that after inoculation parasites may appear and multiply in their blood, show no marked symptoms of infection.

Trypanosoma evansi has a similar pathogenic range to *T. brucei*. Surra is essentially a disease of horses, camels and dogs, whereas in cattle a mild, chronic form occurs, the majority of animals showing little or no outward evidence of infection.

In addition to the pathogenic species, a large trypanosome, *T. theileri*, is commonly encountered in cattle. This species, which is in all probability transmitted by tabanid flies, is rarely of economic importance. Premunized animals may, however, relapse to infection when reacting to some other disease, such as rinderpest, thus increasing the severity of the reaction.

Symptoms—Cattle.—In cattle infected with *Trypanosoma congolense* the first evidence of infection is a rise in temperature five to ten days after exposure. In the case of work oxen visible evidence of infection may be present five to seven days later; but in other cattle the disease often develops slowly and several weeks may elapse before untoward symptoms are noticed. Such symptoms are dullness, lack of appetite, and lack of energy. The animal shows discomfort when the eyes are exposed to strong light, and there is some lachrymal discharge. Further symptoms gradually become evident. The animals falls off in condition, the eyes appear sunken, the coat becomes staring, and in milch cows there is a reduction in yield. The lymph glands may be sufficiently swollen to be visible, as in east coast fever, and diarrhœa may be observed. In the final stages the eye often becomes opaque, the animal is extremely emaciated and very weak. A percentage of cattle show œdematous swellings of the throat, dewlap and belly.

The progress of the disease is always hastened by exposure to cold or rain, or by working or when the disease is complicated by a fluke infection.

Infection with *T. vivax* leads to a similar, but usually milder, infection in cattle. Housed cattle, if well fed, may show few definite symptoms, but symptoms may be noted in work oxen and in infected cattle moved to cold, wet districts.

Pure natural infections of cattle with *T. brucei* and *T. evansi* are rarely observed in East Africa. It may be pointed out, however, that it is not uncommon for an animal to be infected with more than one species of trypanosome.

Equines.—Following infection with *T. evansi* and *T. brucei*, the more pathogenic trypanosomes for horses, mules and donkeys, trypanosomes may be found in the blood in from five to eight days. The temperature curve in these animals is usually irregular, showing peaks at varying periods. A tendency to avoid light and a watery discharge from the eyes, muscular stiffness, dullness and depression, are usually present, while œdematous swellings of the legs and abdomen may be noticed for

varying periods. In the later stages loss of condition is progressively more marked, and the animal becomes very weak. Opacity of the eye is usually seen.

Milder symptoms are usually evinced when equines are infected with *T. congolense*, and the infection is not always fatal. As in the case of cattle infected with fly, however, work and exposure to inclement weather will frequently precipitate a more severe form of the disease. *T. vivax* is of little significance in equines.

Sheep and Goats.—The smaller ruminants are on the whole relatively resistant to infection. Natural cases of *T. congolense* infection in sheep have been observed in the coastal region of Kenya and in parts of the Masai reserve, and infections with *T. brucei* and *T. vivax* have been recorded in Kenya and other countries. The symptoms shown are emaciation, œdematous swellings, running at the eyes, and an irregular temperature reaction.

Camels.—Surra in camels may run a "rapid" course, death occurring within a few months, or the infection may be more chronic, lasting several years. The animal loses its appetite and becomes easily tired. The eye is dull and paroxysms of fever occur at intervals. Oedema of the abdomen, sheath and pads is sometimes seen. In the more slowly developing cases, emaciation is very marked, and paralysis may be observed before death. Such cases often terminate with a secondary pneumonia.

Dogs.—Dogs are highly susceptible to infection with *T. brucei*, *T. evansi* and *T. congolense*. The course of the disease is, however, as in other animals, chronic. There is a primary temperature reaction, followed by an irregular up and down curve. Lack of appetite and progressive wasting are noticed. Eye symptoms develop early, opacity of the anterior membrane of the eye being frequently seen. Oedematous swellings of the legs are particularly common in *T. brucei* infections. Jaundice may be present. In the later stages there is great weakness and apathy. Breathing appears difficult and the pulse becomes almost imperceptible.

Dogs are usually relatively resistant to *T. vivax* infection.

Post-mortem Lesions.—A definite diagnosis of trypanosomiasis can rarely be given from the appearance of the organs alone. The carcass is emaciated, anæmic and the subcutaneous tissues and the muscles are watery. The spleen may be enlarged; the lymph glands swollen and soft.

Diagnosis.—Although trypanosomes may be numerous in the blood during the early stages, they become scanty as the disease progresses. In animals showing an irregular temperature curve, there is an increase in numbers during the period in which the temperature is elevated, and in some cases a further increase occurs in the blood shortly before death. When possible, therefore, both thick and thin smears for diagnosis should be made while the temperature is high. Wet smears are often a help in making a diagnosis. In a drop of blood placed on a slide and covered with a cover-slip the motile parasites can often be detected under the lower power of the microscope much more readily than they can be found by searching a stained smear with an oil-immersion lens. Gland smears may reveal the presence of parasites when blood smears are negative, and are particularly useful in *T. vivax* infection.

Immunity.—When natural recovery from an attack of trypanosomiasis does occur, premunity similar to that following redwater and anaplasmosis infection, but more unstable, frequently develops. The animal becomes a carrier, and relapses may occur if the animal is exposed to unsuitable conditions or if it contracts some other disease. Drug treatment of infected animals may result in the destruction of all the parasites, when the animals become completely susceptible to reinfection.

The game animals of Africa complicate the control of nagana. In fly belts, antelopes and other game harbour infection without showing symptoms, and hence act as reservoirs of infection. Similarly, camels and, to a lesser extent, cattle act as reservoirs of infection of the parasite of surra.

Treatment.—The treatment of trypanosomiasis is a wide and difficult subject, and only a brief summary can be given here. Early cases of *T. brucei* and *T. evansi* infection usually respond to treatment with Naganol (Bayer 205) and its English and French representatives, Antrypol and Fourneau 309. Once the disease is advanced, however, there is little hope of effecting a cure. In *T. vivax* infection a number of drugs which will usually effect a cure (tartar emetic, Antimosan or the British equivalent, Stibophen, and Congosan (Surfen C), for example) are available. In *T. congolense* infection treatment is often useless. Many cases respond to repeated doses of tartar emetic or Antimosan or to single doses of Congosan, but in some animals these drugs produce no effect. The Naganol compounds are of no value in cases caused by *T. congolense*.

Phenanthridium compounds, numbers 987 and 1553 are probably the best treatment for *T. congolense* and *T. vivax* infection in cattle.

Dosage.—Stibophen is obtainable as tablets and one of these is dissolved in 40 c.c. of sterile water and is a single dose for an average bovine. This is given as a subcutaneous injection, a course of four or five doses being necessary. The Phenanthridinium compounds are dissolved in sterile water at 1 per cent strength, the dose is estimated at 1 c.c. per hundred pounds live weight and given either intramuscularly or intravenously. This dosage has been proved to be safe under field conditions, but if greatly exceeded may cause a severe reactive condition known as photosensitization in animals exposed to bright sunlight.

Control of Trypanosomiasis.—Although in certain circumstances the destruction of game animals, that act as reservoirs of the parasites and provide the main food supply of the tsetse flies, has done much to eliminate trypanosomiasis, the main trend of modern experimental work is towards the discovery of cheap and efficient methods of eradicating the fly. A vast amount of work has been done on this subject, and it is impossible to deal with it here. Each fly area appears to present a distinct and individual problem, and methods of attack likely to be successful can only be devised after a detailed survey by an entomologist who has specialized in this subject. Such methods of attack can even then be regarded as only experimental and as more likely to lead to a reduction in the numbers of fly than to complete eradication.

A warning may not be out of place as to the dangers of attempting control without expert advice. As an example of the intricacy of the subject, it may be mentioned that, in certain areas, regular grass burning, carried out under a definite plan, has led to a marked reduction in the number of fly, whereas, in other areas, the prohibition of grass burning has produced the same effect. Probably the only generally successful method of combating fly is the introduction of dense, compact agricultural development of the area. Unfortunately, in many dry, infertile districts such development is not possible.

WILTSHIRE WAR-EFFORT

The position for the harvest in 1943 as compared with that of 1939 was that—

(i) the acreage of bread-corn (wheat, barley and rye) has been increased two-and-half times;

(ii) the potato acreage has been increased sixfold;

(iii) flax has again been introduced and the acreage in the county is sufficient to maintain the new factory erected at Devizes. Last year the in-take was 6,000 tons of flax;

(iv) the area devoted to vegetables has extended from 790 to 2,000 acres, while glass-house production of salad crops and tomatoes has been increased by 50 per cent;

(v) at the same time milk production has been fully maintained. This in itself is a large industry, producing several million gallons a month, and has involved the maintenance of a large number of cows and heifers. It is interesting to note that for the year ended September, 1943, the average *sales* of milk from 100,000 cows and heifers was 570 gallons per head. Other cattle have been increased by approximately 8 per cent.

Agriculture (Journal of the Ministry of Agriculture, England)

LOCUSTS AS A PROTEIN SUPPLEMENT FOR PIGS

By W. R. T. Hemsted, Central Veterinary Research Institute, Kabete, Kenya

(*Received for publication on 3rd March, 1947*)

Locusts are relished as a food by many African tribes. Up to the present locust destruction on a large scale has depended on bait poisoning these insects, usually with an arsenical compound. Recently di-nitro-ortho-cresol has been extensively used as a locust poison and, as this compound has a very low toxicity for stock, the possibility of utilizing locusts killed by it as a stock feed has been investigated; the results of this inquiry are reported in this paper.

Toxicity of D.N.O.C. for Stock.—A preliminary experiment was undertaken to find the minimum lethal dose of D.N.O.C. for sheep, and these trials showed it to be 1.8 mg./kg. live weight. Toxicity tests were not carried out with pigs.

Preparation of a Stable Locust Product.—The locusts were sun-dried, with frequent turning, for a week. The dried insects were then pounded to a coarse meal. Fresh locusts when mashed have a decidedly offensive smell, but this odour was almost totally absent from the dried meal, which kept well when stored in sacks.

Moisture Content of Locusts.—Fresh locusts were found to contain 70 per cent and sun-dried specimens had only 8.03 per cent water, thus the sun-drying had reduced the mass of the fresh locusts by 62 per cent. The powdered meal was easy to prepare in the dried state and the cost of this processing would be very moderate, depending, in the main, on the means available for collecting, drying and grinding the locusts.

Chemical Composition.—Two pounds of hand-picked red locusts were dried over a water bath until they became brittle. These were ground into a fine flour, care being taken not to express any fat, and the powder was further dried to constant weight and analysed for the chief food constituents with the results given below:—

	Dry Matter Basis	Sun-dried Basis	Wet Matter Basis
	%	%	%
Moisture	—	8·03	70·57
Ash	8·715	8·015	2·565
Crude Protein	63·470	58·37	18·68
Fat	14·12	12·97	4·15
Fibre	13·54	12·44	3·98
P2O5	0·16	0·15	0·055
CaO	0·1344	0·1236	0·03955
	0·2839	0·2611	0·08354

The chemical composition given above suggested that locust meal was worthy of trial as a protein supplement and the CaO/P_2O_5 ratio of 2:1 would be of value in correcting the adverse ratio found in cereal products, particularly local maize with its ratio of 1:51 (Hudson, 1944).

Feeding Trials.—Locust meal prepared as already described was mixed with standard cereal mix-meal to give an estimated total protein content of 20 per cent. This was fed to three weighed weaner pigs in quantities based on body weight as advised by Morrison (1936). A large handful of dried lucerne, about 2 lb., was fed to each pig daily as a green supplement. This mixture proved very palatable to the pigs and was normally completely devoured within 15–30 minutes. The pigs were weighed twice a week at a fixed hour. One pig, No. 2590, developed a gross umbilical hernia and was slaughtered after 25 days on this diet. The growth rate of the two other pigs was very satisfactory and is given below in the form of a graph.

Weight Increase in Relation to Food Eaten

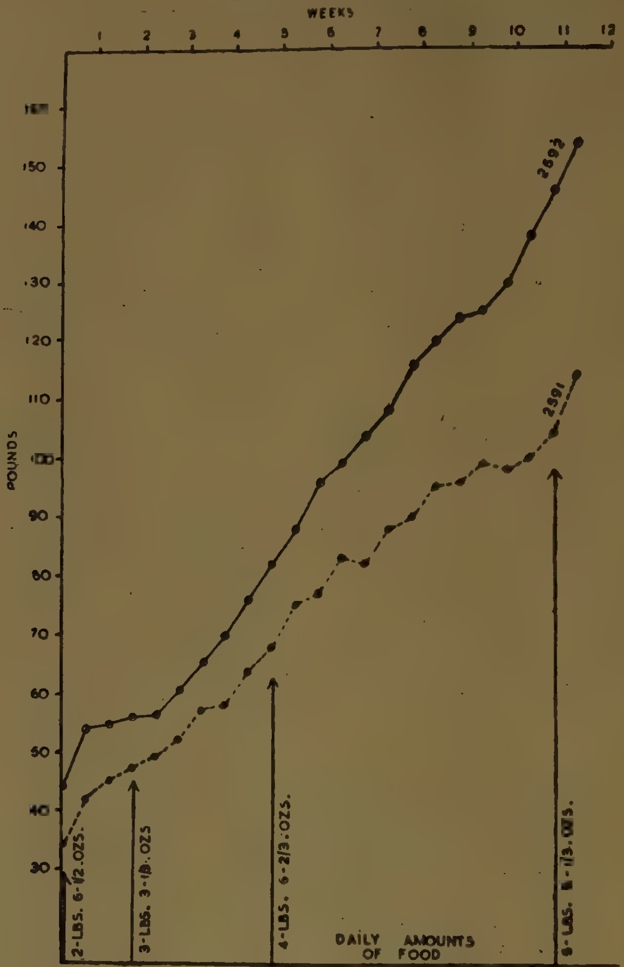
Pigs Nos. 2592 and 2591 were on this locust mix-meal ration for eleven weeks, when the supply of locust meal was exhausted. Pig No. 2592 made a daily average gain over this period of 1 lb. 7 oz. on a daily average of 3 lb. 14½ oz. of food. Pig No. 2591 gained 1 lb. 0¾ oz. daily on 3 lb. 14½ oz. of food.

Taint of Flesh and Fat

Pig 2590, after slaughter, was divided into 16 portions. One portion was given to each of 16 Europeans to cook, eat and report. Fifteen of the 16 assessors reported that they had detected a "fishy" taint which was most marked in the fat. Those who had chops and fried them reported that the taint was slight, whilst in the larger portions or joints it was more pronounced.

Pig 2592 was sent to Uplands Bacon Factory and slaughtered for bacon curing. The factory reported that the fresh carcass had a very marked "fishy" smell. The cured sides were returned to the laboratory. The bacon had a very distinct odour reminiscent of kippers. This was again divided into 16 portions and issued to 16 volunteer assessors. Again fifteen reported that the bacon or ham had a distinct taint and four of these found the bacon

GROWTH RATE OF PIGS



inedible owing to the strong "kipper" flavour. It was noticeable that the taint was concentrated in the fatty portions.

Pig No. 2591 was kept on a normal ration, free of locusts for three weeks after the conclusion of the locust diet, and was then slaughtered for bacon curing. The fresh carcass had a definite fish taint. The cured sides did not smell abnormally, and these were divided and given to twelve people to consume. Three reported a mild taint, and of these one found the taint so obnoxious that he could not eat the bacon.

QUALITY OF FAT

The fat from each of the three pigs was examined with the following results:—

Pig	Source of Fat	Iodine No.	Melting Point
2590	Shoulder	69·2	30°C.
2592	Kidney area	57·2	42·5°C.
2591	Shoulder	66·4	43°C.

SUMMARY

Locusts killed by D.N.O.C. can be dried and kept as a meal.

Such meal is rich in protein.

Pigs ate a ration containing locust meal with apparent relish. Pigs on diet balanced with locust meal thrived and made satisfactory gains in weight.

Fresh meat or bacon cured from pigs fed locust meal had a definite fishy taint.

Three weeks rest from the locust diet reduced the taint but it would appear a longer period than this was needed if all the taint were to be eliminated.

The taint was most noticeable in the fat.

I wish to record my thanks for much advice and help in carrying out this work that I received from Mr. J. R. Hudson, Deputy Director (Laboratory Services) and Dr. H. S. Purchase.

REFERENCES

Hudson, J. R. (1944).—*E. Afr. Agric. J.*, X, 1.
Morrison, F. B. (1936).—"Feeds and Feeding", 20th edition, Morrison Pub. Co., Ithaca, N. Y.

PHORMIUM FIBRE
(NEW ZEALAND FLAX)

By Alfred Wigglesworth of Wigglesworth & Co., Ltd., London

(*Received for publication on 24th February*, 1947)

The production of Phormium Fibre in Kenya has lately drawn attention to this industry. The present world-wide shortage of cordage fibres makes East African Phormium readily saleable at remunerative prices at this time. The fibre is softer and can be used for purposes where true hard fibres are less adaptable. It suffers, however, from certain disadvantages, so that careful assessment of its value and production cost would be advisable before encouraging large scale production in Africa.

Phormium Fibre (*Phormium Tenax*) originated in New Zealand, where it is named New Zealand Flax; but it has nothing whatever in common with true flax (*Linum Usitatissimum*), the fibre from which linen is manufactured and which is grown in temperate countries all over the world. Phormium is produced commercially not only in New Zealand, but also on a small scale in the Azores, St. Helena and the Argentine. In none of these countries has it so far proved particularly successful.

The New Zealand exports have dropped from 28,500 tons in 1907 to nil at the present time. The Dominion continues to produce, but only on a greatly reduced scale, the aim being to secure better quality than before by cultivating superior strains and improving the preparation of the fibre. New Zealand's experience is valuable in estimating future prospects in East Africa. Since 1916, when exports were 27,000 tons, the decline has been almost uninterrupted. The average value per ton of the exports varied between £18 in 1890, £36 in 1916 and £11 in the depression year 1933; in 1939 it was approximately £16. Obviously no fibre could be produced at such a price and no subsidy within reason would suffice to make up the deficiency. The current production is all used locally for the manufacture of wool packs, cordage and upholstery. About 5,000 tons are employed for these purposes. There is no likelihood of any early resumption of exports, since production is substantially below local requirements.

In spite of its inherent advantage in softness over other hard fibres, Phormium does not command higher prices than African sisal, unless equal in quality to the higher grades of New Zealand fibre, which, however, can only be produced by a somewhat complex and expensive process. Inferior grades, less well cleaned and considerably darker than sisal fetch lower prices. All Phormium suffers from weakness compared with sisal and manila hemp, carrying greater wastage in spinning. Another serious handicap is that as yet no efficient system of stripping the fibre has been evolved to compare with sisal decortication, nor is the production organized as highly as is that of sisal. Present methods are wasteful and tend to damage the fibre. Heavy subsidies are paid to keep the industry alive in New Zealand, but notwithstanding these there is little encouragement for growers to persevere, as high labour costs and other factors are against them.

The industry has failed likewise to make progress in St. Helena and the Azores, where production is very small. Some progress has been made in the Argentine, but again only for the purpose of supplying a small part of local fibre needs.

It would appear that unless conditions in East Africa are exceptionally favourable in soil, climate and labour for producing high class Phormium at low cost, the long term prospects of the industry are more than doubtful. By developing better yielding plant varieties of improved strain and evolving better stripping methods progress may possibly be made.

Low wages in Africa put the industry in a better position than in New Zealand, where labour is paid a minimum of £1 a day, but against this the conditions in Africa are by no means favourable for the production of high class fibre. The mild climate of New Zealand with alternating winter and summer, rain and sunshine presents a very different picture to the blaze of the vertical sunlight which pours down on the African prototype, extracting much moisture from the soil and preventing the plant and fibre from gaining its customary strength by rapid growth in summer and rest in winter.

THE VEGETATIVE PROPAGATION OF CINCHONA BY CUTTINGS

By L. M. Fernie, Superintendent of Plantations, E.A.A.R.I., Amani

(*Received for publication on 14th March, 1946*)

In all perennial crop plantations where propagation by seed is the normal practice, considerable variation in material is evident, and in this respect cinchona is no exception. An alternative method is to use vegetative propagation, by which means the desirable characters of the parent plants can be perpetuated and uniformity obtained. An added advantage is that a fully developed plant is usually obtained in less time than when raised from seed, though Owen [16] considers propagation by cuttings to be slow and uncertain and never likely to be as popular as by seed. But Kreyer [12] rather surprisingly states that sexually reproduced cinchona trees are said to give considerably higher yields than those reproduced vegetatively.

In the early days of cinchona cultivation, multiplication by means of cuttings was resorted to on a large scale in the absence of adequate seed supplies. Later, in Java, grafting methods were perfected for use in the improvement of stock; mother-trees were selected for vigour, thickness of bark, and high quinine content, and clonal races were established. Recently the Russians have resumed investigations on the mass production of rooted cuttings for a specialized system of cinchona culture peculiar to the conditions prevailing in the sub-tropical parts of Russia.

Methods of vegetative propagation may be grouped under two headings: (1) By inducing roots to form on parts of parent plants; this includes all types of cuttings and layering and its variations. (2) By growing parts of the parent plants on root-stocks of other plants; this includes budding and grafting. Of these, grafting has been the most usual, though cuttings have been used fairly extensively, and layering was adopted in India as a means of establishing stock plants from which to take cuttings [11].

Propagation by cuttings avoids the necessity of raising root-stocks for grafting, and also eliminates difficulties of stock/scion influences; King [11] states that with *C. succirubra*, propagation by cuttings is easier and to the inexperienced cultivator, safer than by seed. On the other hand, considerable diversity of opinion appears to exist as to the ultimate success of trees raised from cuttings. In Ceylon [2], some attributed fatalities to rooted cuttings failing to produce tap-roots; others regarded this as an advantage, there being no tap-root to go down into the damp, stiff, clay subsoil. Christie [4] noticed no difference between seedlings and cuttings from suckers, which grew as well and were as long-lived. Kreyer [12], reporting on methods in Russia, states that in other countries seedlings are thought to have stronger root systems than plants raised from cuttings. In the Belgian Congo, Stoffels [17] reports the abandonment of multiplication by cuttings, because the root system is not well developed, consisting of many fine roots but no tap roots.

Whatever the verdict, Mayne [14] considers that vegetative propagation would provide a means of rapidly building up stands of high-yielding trees to provide seed supply, if they should prove too cumbersome or expensive for field planting.

Historical

The first record of a successfully rooted cutting of cinchona comes from Java in 1852. According to Gorkom [8] one cutting was obtained by Teijsmann at Buitenzorg in that year from a plant of *C. calisaya* obtained from Paris and sent out to Java. It thrived though the parent plant died, and a second rooted cutting was obtained from the first. Until 1865 propagation was largely by cuttings, because the best trees in Java still failed to produce seed. After that year, as more seeds were harvested, propagation by cuttings was abandoned except for *C. succirubra* and *C. officinalis*. In 1872, after the discovery of *C. ledgeriana*, thousands of plants were obtained by cuttings, since no seeds were available; but the method was not entirely successful with this species. Grafting trials on *C. succirubra* root-stocks were commenced in 1879, and it was claimed that plants so worked grew quicker and stronger than cuttings. This is now the routine method in Java.

Similarly, when cinchona was introduced into India and Ceylon in 1861, propagation was largely by cuttings until adequate seed supplies became available; this method was then abandoned. Propagation by layers and axillary cuttings was also carried out on a limited scale in the early days, but was superseded by cuttings.

More recently, large quantities of cuttings have been raised under glass in the sub-tropical parts of Russia; there they are planted in the field at the rate of 40,000 to the acre, and at harvest the whole of the young plant is used in the manufacture of cinchona alkaloids [5].

Methods of Propagation

The parts of a plant which can be used for making cuttings are: roots, leaves, stems, modified stems and buds. Since cinchona does not possess tubers, rhizomes or similar structures, propagation by modified stems does not apply here; cuttings of the other types have all been tried and are discussed below.

Root Cuttings

Plants that naturally produce suckers freely from the roots can usually be propagated by root cuttings. Cinchona is not of this type, and therefore success was not expected; no record has been found of this method having been attempted elsewhere.

At Amani roots of *C. ledgeriana* were planted in both open and closed frames in river sand, and in a mixture of coco-nut fibre and coarse river sand. Some cuttings were planted vertically with the proximal end above the rooting medium; others were buried horizontally. After eight weeks some roots were formed on a few cuttings which had been buried horizontally in river sand in an open frame. There was no sign of any adventitious buds or shoots, nor did these develop subsequently. Roots tended to arise at points along the cutting and not from the callus ring at the cut ends. No roots were formed on those cuttings planted vertically, nor on any of those in the closed propagating frames. This method was abandoned as impracticable.

Leaf and Axillary Bud Cuttings

Leaves of certain plants are able to produce new plants, but there is no record of this having been tried with cinchona.

Fairly mature leaves of *C. ledgeriana* were planted in a medium of river sand in closed propagating frames both with and without bottom heat. After eight weeks, a few cuttings in the medium without bottom heat had rooted; no shoots developed. The leaves were planted with their stalks retained and roots were formed only from these stalks. Leaves in the medium with bottom heat rotted before any roots were produced.

In making an axillary-bud cutting a mature leaf is cut away from the stem in such a way that the bud in the leaf axil is removed with it. This is similar to removing a bud for budding purposes, except that in this case rather more wood should be taken with the bud. Success depends mainly on the presence of a large healthy leaf, which must be retained until the cutting has rooted.

According to Owen [16] propagation by axillary-bud cuttings was practised in the early days, but was later abandoned in favour of stem cuttings and seed. The method of preparation in those days was somewhat different. An ordinary cutting was taken and severed on both sides of a node; the stem was then split down the centre so as to retain a leaf and bud intact.

The method was tried at Amani in a medium of river sand in closed propagating frames, both with and without bottom heat. After eight weeks 20 per cent of those in the medium without bottom heat had rooted, and shoot growth was commencing. No roots formed on those in the medium with bottom heat, although a few showed considerable shoot growth; subsequently these all rotted.

Stem Cuttings

Stem cuttings may be divided into hardwood cuttings and softwood cuttings. An intermediate stage between these is sometimes referred to as semi-hardwood cuttings.

Hardwood Cuttings.—These are made from the ripe wood of the season's growth, or of older wood. Gorkom [8] states that, as a rule, cuttings succeed better with soft than with hard wood. This agrees with experience at Amani, where hardwood cuttings of *C. ledgeriana* have not been successful. On the other hand, Theunissen [18] reports some success with woody and half-woody cuttings of *C. succirubra*, *C. ledgeriana* and *C. hybrida*, planted in beds of alluvial soil. Cuttings were taken from five- and two-year-old trees and planted up to the second node. Beds were shaded by bamboo screens and a grass mulch was spread between the cuttings. The best chance of success was with the first rains when vegetative growth re-starts.

At Amani hardwood cuttings with and without leaves were set in a medium of river sand in closed and open frames. Some cuttings were taken with a "heel", others with a clean cut at the base; a further treatment was the use of bottom heat. All cuttings were *C. ledgeriana*. With leafy cuttings practically all the leaves fell soon after planting, rendering this method ineffective. After sixteen weeks a

few cuttings both with a "heel" and a clean cut at the base rooted in a closed frame without bottom heat. All those with bottom heat rotted off without showing signs of root growth, nor were roots formed on any of those in the open frame.

Softwood cuttings planted at the same time and under the same conditions showed a 50 to 60 per cent "take" after eight weeks, and their superiority over hardwood cuttings is clearly demonstrated.

Softwood Cuttings.—These are made not only from plants whose tissues are always relatively soft (i.e. herbaceous cuttings), but also from the soft tissue of woody plants. These latter cuttings are usually the tips of shoots and branches still in active growth or which have just completed growth. Softwood cuttings are succulent and tender, and special precautions must be taken to prevent wilting. The presence of leaves causes a high rate of transpiration, which makes this difficult; the use of glazed propagating frames is therefore essential.

This type of cutting has proved to be the easiest and quickest to root at Amani, and therefore the methods and the results are described in detail. Other workers confirm the desirability of this method. Christie [8] states that all cuttings should be of softwood. Kreyer [12] found that the most suitable method of vegetative propagation in South Russia was by softwood cuttings, rooted under glass or in the nursery. In the Belgian Congo, Stoffels [17] found that cuttings made from young wood, still with leaves attached, rooted more easily.

Variation in Rooting Response

Considerable variation in rooting response with cinchona and its varieties is apparent. All workers agree as to the ease with which *C. succirubra* cuttings may be rooted. Owen [16] states that other species are much less easily raised from cuttings; Gorkom [8] considers that with most species cuttings are troublesome with the exception of *C. succirubra* and *C. officinalis*, both of which were very successful. The latter also found that results varied widely according to the season and the plant from which the cuttings were taken. Christie [4] on the other hand, maintains that all species, including *C. ledgeriana*, are equally easy, providing that suckers are available.

Four kinds have been tested in this respect in various experiments at Amani. They are: *C. josephiana*, *C. ledgeriana*, *C. succirubra* and *C. hybrida* (*C. ledgeriana* x *C. succirubra*).

Of these, *C. succirubra* has been consistently the easiest and quickest to root in all trials and treatments, and *C. josephiana* the most difficult; there is little difference between the other two.

The mean percentages of all stem (or sucker) cuttings rooted in sand in three different experiments are given in Table I below. In this, and in all other tables, treatments that have proved unsuccessful have been omitted, except when such treatments are used for comparison.

TABLE I

Expt.	*ledgeriana*	*hybrida*	*succirubra*	*josephiana*
	%	%	%	%
1	69	81	95	—
3 Rep. 1	62	58	79	30
3 Rep. 2	72	71	82	43
Mean	68	70	85	36

Species responses to different treatments are shown later under the treatment headings.

Material for Cuttings

In Java in 1865-66, when cuttings could be obtained from young, robust seedlings, Gorkom [8] claims that results were at once more favourable. King [11] states that the young wood of trees of *C. calisaya* growing in the open air will not do for cuttings; yet, if these same trees are forced in a hot-house these cuttings are almost sure to succeed. Accordingly, stock plants, which yield a crop of cuttings every one to two months, were established from layered branches; when rooted they were transplanted six inches apart into good soil in glazed frames. In Russia the supply of cuttings is obtained from stock plants growing outside in shaded beds in summer or in glass-houses during the winter [5].

King [11] in India, Owen [16] in Ceylon, and Feilden and Garner [5] reporting work in Russia, agree that thin cuttings of the current year's growth are best; Feilden and Garner add that shoots on the upper non-woody part of the stem are too thick and take longer to root.

All workers apparently agree as to the desirability of obtaining cuttings from stems or suckers rather than from branches. This is generally contrary to experience with most other plants. Owen [16] recommends shoots on the lower part of the stem and points out that the ends of branches will also do, but are not so suitable. According to Gorkom [8] the

best results were always obtained from the shoots which developed from the stems of *C. ledgeriana* trees which had been coppiced for the bark harvest. Christie [4] found that the tips of branches do not root freely, take longer, and require bottom heat. He also found that such cuttings, when rooted, do not grow so quickly, and unless pruned are inclined to get bushy.

According to Feilden and Garner [5] the output of material for cuttings in Russia was increased by cutting the parent trees back to four inches above ground-level, and pegging down the resultant shoots by their tops so that they form an arc. Dormant buds along the shoot start growing as a result of the tension set up; these are taken as cuttings when three nodes have been formed, leaving the lowest node for further shoot development. A three-year-old bush so treated produces 60 to 80 cuttings. This method is similar to that recommended by Fernie [6] for the establishment of a clonal nursery for intensive propagation of coffee by cuttings.

In the initial trials at Amani the tips of young seedlings were used in an attempt to obtain large numbers of plants quickly. This material proved relatively easy. Later, trials were laid down using cuttings made from the terminal shoots of both stems and branches of mature trees. All the four species previously mentioned were used in these trials, which were partially confounded with other treatments; there were two replications.

Results showed that with all species, stem cuttings proved superior to branch cuttings. One possible explanation of this is that the stems appeared to be more succulent, whereas the laterals were inclined to be woody at the base.

The mean percentages of all cuttings rooted in sand after twenty-four weeks in the propagating frames are shown in Table II.

TABLE II

Expt.	Type of Cutting	*ledgeriana*	*hybrida*	*succirubra*	*josephiana*
		%	%	%	%
3 Rep. 1. ..	stem	62	58	79	30
	branch	27	25	51	26
3 Rep. 2. ..	stem	72	71	82	43
	branch	23	36	65	26
Mean ..	stem	67	64	80	36
	branch	25	30	58	26

Preparation of Cuttings

Softwood cuttings are best taken in the early morning when the relative humidity is comparatively high. They should be taken to the nursery without delay and each one trimmed and recut at the base before planting. The length of cutting is probably immaterial provided that the leaf area is proportional to the size of the cutting, and that the cutting itself is of true soft wood, and not semi-woody at the base.

In India, King [11] recommends that cuttings of *C. succirubra* should be taken just below a node; the larger leaves should be removed except for their bases, but the younger unexpanded ones should be allowed to remain. With *C. calisaya*, the fully-developed leaves are halved, and the young ones left whole.

Owen [16] states that the shoot, after removal, should be re-cut at an angle just below a node, four to six inches from the top. All large leaves should be removed, but the pair at the top should be left. He goes on to say that the upper portion only of each shoot should be planted, as lower portions do not produce such healthy plants, though they will root. In Java the cutting was usually a shoot three and a half to eight inches long, possessing two or more nodes; the basal cut was horizontal below a node. With coppiced *C. ledgeriana* trees, however, the shoots were taken off with a "heel" [8]. Christie [4] favours cuttings four to six inches long with the basal cut close to a node, leaves cut off, and the terminal bud topped. In Russia [5], the cutting is taken when the young shoots have made three pairs of leaves. The usual cutting is about one and a quarter inches long and must consist of at least two internodes. The basal cut can be made above the node without lessening the probability of root formation; the leaves are not shortened.

Trials were made at Amani with the basal cut through a node and through the centre of an internode. Indications were that root production is slightly improved when the basal cut is through or just below a node, but an internodal cut by no means prohibits rooting. It was interesting to note that with internodal cuts roots were mostly formed at the base above the callus ring, but some roots and numerous rootlets were visible between the basal cut and the basal node. When the cuts were nodal, roots nearly all arose from the base just above the callus ring, and none were visible along the internode.

Detailed results, including total percentages at different intervals, are shown in Table III, all cuttings being *C. ledgeriana.*

TABLE III

Weeks	Bottom heat		No Bottom heat	
	Nodal	Internodal	Nodal	Internodal
	%	%	%	%
8 ..	46	36	62	50
12 ..	54	52	74	64
24 ..	68	60	92	78

Leaves from the basal portion of the cutting are usually removed and the remainder trimmed to prevent straggling and to save space in the propagating frames. Great care must be taken to retain as many leaves as possible since all softwood cuttings are said to root sooner and in greater numbers when leaves are present; in fact their absence may preclude rooting. If ample space is available, it would be preferable not to remove or trim any leaves except those damaged or diseased.

Planting of Cuttings

At the Government Cinchona Plantations on the Neilgherries in India [9], cuttings were planted in four-inch pots in propagating frames. King [11] states that cuttings of *C. succirubra* can be planted in the open, in beds, or in boxes, with a thatched roof. *C. calisaya* cuttings are planted in shallow boxes. In Ceylon, according to Owen [16] cuttings should be planted in shaded beds as for seedlings and in all ways treated as such, though, once struck, far less attention is needed. It is also recommended that the cut end should rest on a piece of dry brick or in brick dust so that the juice which flows from the cut may be absorbed and not cause mildew and rot. When bottom heat is used, cuttings are planted in pots and plunged in beds of deep sand in the propagating frames. A frame three feet square will hold 1,200 cuttings. Gorkom [8] found that many cuttings of *C. ledgeriana*, when planted in the open, developed slowly or not at all. He states that the raising of cuttings must always be carried out in propagating houses. When using suckers, Christie [4] recommended planting in a covered bed; the lower node should be two inches below the surface and the cuttings gently pressed down. When suckers are unobtainable and recourse is made to branches, he recommends planting four inches apart in prepared beds with bottom heat, and covering with a bell-jar or the upper half of a light-coloured bottle. In Russia [5], cuttings are raised in cold frames and unheated glass-houses in summer, and in winter with bottom heat in frames in hot-houses. Spacing in the beds is usually two by two inches. Kreyer [13] states that cold frames can be used for cuttings. Bodski and others [3] experimenting on the growing of cinchona cuttings under glass, claim that better results were obtained when the glass of the frames was replaced by cellophane. Mayne [14] suggests that if large quantities of material are required, it will probably be necessary to install propagation houses, for control of the environment, so that the work could not be seriously interrupted by seasonal variations.

As stated previously, successful rooting of softwood cuttings is largely dependent on the retention of healthy leaves. For this reason, it was found necessary at Amani to plant the cuttings in a closed propagating frame where a high humidity can be maintained. No success was obtained in open beds. Frames are best constructed of concrete or brick and may be of any convenient size, the limiting factor probably being the frame lid, which must be of a size that is convenient to handle. Since softwood cuttings require plenty of light, the lids must be glazed.

The Regulation of Moisture, Temperature, and Light

With *C. calisaya* in India, King [11] states that mats are laid on the glazed frames to provide shade when the sun's rays are too powerful. An equable moisture is maintained in the frames; ventilation is provided by opening the frames for half an hour to an hour in the early morning, and, at times, by keeping them slightly ajar by means of a stone or stick; watering is done carefully with a fine syringe. He insists that the leaves should never be allowed to be wet in the evening or at night. He considers that in a climate favourable for cinchona cultivation, it is not necessary to use bottom heat.

In Ceylon, Owen [16] found that species other than *C. succirubra* appear to require bottom heat. The employment of bottom heat was a means of forcing the cuttings to root more quickly; glass-covered frames were useful for this, and though expensive, artificial heat was necessary for the propagation of valuable species of cinchona. He recommends a flue of hot air or water below the rooting medium as the best form of bottom heat, which should not exceed 75° F.

For stem cuttings, Christie [4] insists on the admission of light and air and the exclusion of direct sunlight; watering should be done as for seedlings. When attempting to root branch cuttings, he recommends the use of bottom heat in the form of a layer of fresh cattle manure, 18 inches thick, beneath the rooting medium. In Russia [5], cold frames were used in summer; in winter the rooting medium was maintained at a temperature of from 71° F. to 82° F. by means of bottom heat. Temperatures over 82° F. were found to injure roots, while at 60° F. rooting was retarded. In small-scale experiments, rooted cuttings have survived temperatures of 20° F. Factors employed with success in producing increased winter-hardiness are a short day of eight hours' light, no shading, and a minimum of watering, while during the winter all the light possible must be admitted.

Softwood cuttings require plenty of light, but it is important that direct sunlight should not be allowed to fall upon the propagating frames, as this scorches the tender young leaves, and makes it impossible to maintain a high humidity. At Amani, an overhead shade of hessian has proved very satisfactory.

Adequate drainage was provided at Amani by means of a small drain at the bottom of the frame. Stones were placed on top of this, with a final layer of pebbles on which to place the rooting medium; if bottom heat was obtained from the use of cow manure, this was placed on top of the drainage material to form the base of the rooting medium.

The cheapest method of providing bottom heat is by means of a layer of fresh horse or cow manure immediately beneath the rooting medium. Cow manure is probably more readily available in the tropics, but gives less heat than horse manure. In a concrete frame of the type mentioned above, the provision of manure must obviously be at the expense of drainage and is bound up with the question of the moisture content of the rooting medium. Bottom heat aims at providing a higher temperature at the base of the cutting than at its tip, in an endeavour to stimulate root formation before shoot growth commences.

In one experiment, temperatures were recorded daily at 8 a.m. and 2 p.m. in heated and unheated plots The thermometers were placed at the same depth as the cuttings, approximately one to two inches. The rooting medium was washed river sand four inches deep. Drainage stones were dispensed with in the heated plot, and a layer of fresh cow manure twelve inches deep was substituted. The mean temperatures recorded morning and afternoon over a period of 24 weeks are shown in Table IV. The difference in temperature due to the bottom heat and the variations between morning and afternoon recordings are also shown.

TABLE IV

Weeks	Bottom Heat				No Bottom Heat				
	8.00 am.	2.00 pm.	mean	Variation	8.00 am.	2.00 p.m.	Nean	Variation	Difference
1	25·8°C	32·0°C	28·9°C	6·2°C	21·7°C	27·3°C	24·0°C	5·6°C	4·9°C
2	25·4	29·4	27·4	4·0	20·8	24·3	22·6	3·5	4·8
3	27·2	32·0	29·5	4·7	22·6	27·7	25·1	5·1	4·4
4	27·6	32·4	30·0	4·8	22·7	28·4	25·6	5·7	4·4
5	26·6	33·1	29·9	6·5	22·3	29·6	25·9	7·3	4·0
6	27·0	31·8	29·4	4·8	23·0	29·0	26·0	6·0	3·4
7	27·4	32·7	30·1	5·3	24·1	30·1	27·1	6·0	3·0
8	26·8	31·1	29·0	4·3	23·7	28·8	26·3	5·1	2·7
9	25·6	30·7	28·1	5·1	23·1	28·6	25·8	5·5	2·3
10	25·3	30·7	28·0	5·4	22·8	28·7	25·8	5·9	2·2
11	25·0	32·8	28·9	7·8	22·7	31·0	26·8	8·3	2·1
12	25·4	31·7	28·6	6·3	23·4	30·1	26·8	6·7	1·8
13	24·8	29·6	27·2	4·8	23·4	27·6	25·5	4·2	1·7
14	24·7	32·1	28·4	7·4	23·4	29·8	26·6	6·4	1·8
15	25·1	32·1	28·6	7·0	23·3	30·3	26·8	7·0	1·8
16	25·1	32·7	28·9	7·6	23·8	31·0	27·4	7·2	1·5
17	25·4	32·8	29·1	7·4	24·4	30·9	27·6	8·5	1·5
18	26·0	32·7	29·4	6·7	24·8	31·1	28·0	6·3	1·4
19	25·0	34·3	29·6	9·3	24·0	32·6	28·3	8·6	1·3
20	26·6	35·1	30·8	8·5	25·1	33·6	29·3	8·5	1·5
21*	25·0	27·0	26·0	2·0	24·0	26·1	25·1	2·1	0·9
22	24·7	26·7	25·7	2·0	23·4	26·1	24·8	2·7	0·9
23	24·7	26·6	25·6	1·9	23·1	26·1	24·6	3·0	1·0
24	25·0	26·4	25·7	1·4	23·6	25·3	24·4	1·7	1·3
Mean	25·7	31·2	28·5	5·5	23·3	28·9	26·1	5·6	2·4

*Overhead shade increased.

In this experiment the cuttings (all *C. ledgeriana*) rooted better in the unheated plots. There was considerable variation between the morning and afternoon recordings, demonstrating the difficulty of maintaining a constant temperature in the tropics under these conditions. After twenty weeks, the weather became so hot and dry that it was found necessary to increase the amount of overhead shade. The immediate reduction in the variation between morning and afternoon temperatures was then very marked. The effect of the bottom heat showed a steady decline over the whole period.

Table V summarizes the percentages of stem cuttings rooted in sand after 24 weeks in various experiments with and without bottom heat.

TABLE V

Expt.	Treatment	*ledgeriana*	*hybrida*	*succirubra*	*josephiana*
		%	%	%	%
1 ..	Bottom heat	60	82	92	—
	No bottom heat	78	77	95	—
3 Rep. 1	Bottom heat	64	48	72	30
	No bottom heat	60	68	86	30
3 Rep. 2	Bottom heat	80	62	88	56
	No bottom heat	64	80	76	30
4 ..	Bottom heat	64	—	—	—
	No bottom heat	85	—	—	—
Mean ..	Bottom heat	67	64	84	43
	No bottom heat	72	75	86	30

The necessity for bottom heat by means of fresh cow manure is not apparent.

A high humidity must be maintained in the propagating frames to prevent the tender, succulent young cuttings from wilting. This is done by means of a fine mist spray several times a day according to the external temperatures.

Rooting Media

The essentials in a rooting medium are good aeration, retention of moisture, and adequate drainage, and for this sand is the commonest material used. In recent years, peat and peat mixtures have proved efficient rooting media, since they have a high water-holding capacity and are well aerated. Their acid reaction is considered to be beneficial, in addition it is possible that they provide root stimulants.

On the Neilgherries in India [9], four inch pots were filled with prepared soil to within an inch of the surface and filled up with pounded brick dust, into which the cuttings were inserted. King [11] recommends planting in shallow boxes in a mixture of fine decayed vegetable mould and sand, with a layer of pure sand on top to provide drainage. According to Owen [16] a layer of sand on the mould is of use to prevent rotting off at ground level. For stem cuttings Christie [4] found a covered bed with fresh sandy soil sufficient. For branch cuttings, however, he used two to three inches of fine silver sand on top of eight inches of fresh soil, in addition to bottom heat. In Russia [5], sand and bottom heat were used in the propagating houses. In cold frames the rooting medium was a substratum of light, sandy soil of almost neutral reaction overlaid with one and a half inches of sharp sand which had previously been green-manured. The sand in the beds was renewed every six weeks.

The experiments at Amani were carried out with washed river sand and a mixture of coco-nut fibre (chopped and sifted) and coarse river sand, in equal proportions by volume. Unfortunately, peat was not obtainable, but as the coco-nut fibre mixture proved an efficient substitute when used with coffee cuttings [6] it was considered to be worth a trial.

Table VI shows the mean percentages of stem cuttings rooted in each medium.

TABLE VI

Expt.	Rooting medium	*ledgeriana*	*hybrida*	*succirubra*	*josephiana*
		%	%	%	%
3 Rep. 1	Sand ..	62	58	79	30
	Coco-nut fibre sand ..	30	51	81	6
3 Rep. 2	Sand.. ..	72	71	82	43
	Coco-nut fibre sand ..	37	43	64	2
1 ..	Sand.. ..	69	79	93	—
	Coco-nut fibre sand. ..	67	68	97	—
Mean	Sand.. ..	68	69	85	37
	Coco-nut fibre sand ..	45	54	81	4

The superiority of sand over the coco-nut fibre sand mixture is clearly shown; the only possible exception is *C. succirubra* which is so easy that it seems immaterial which medium is used.

Depth of Planting

Cuttings should be planted shallow, the actual depth being sufficient only to hold the cutting upright in the rooting medium. In this way the base of the cutting is kept in the best aerated part of the medium. In Java, cuttings had two or more nodes, one of which was put into the rooting medium and lightly pressed down [8]. Christie [4] planted stem cuttings in covered beds, with the lower node two inches from the surface, and gently pressed them down. At Amani cuttings are planted as shallow as possible one to two inches deep.

Time Required for Rooting

In India, cuttings of *C. succirubra* planted in beds in the open require two to four months to root according to King [11]. In warm weather, good cuttings of *C. calisaya* rooted in frames in from three to four weeks; in cold weather, as much as four to five months elapsed before good roots were formed. Christie [4] found that stem cuttings struck after three months, branch cuttings after four to six months. In Russia [5], it is claimed that thin cuttings rooted in a hotbed in from seventeen to twenty-five days, when they had five to ten roots half an inch long. On the other hand, cuttings from shoots which developed on the upper non-woody part of the stem were too thick and took several months to root.

At Amani, *C. succirubra* rooted very quickly and easily, a high proportion having a mass of strong sturdy roots in under eight weeks. A typical example of the percentage of *C. ledgeriana* which may be expected to root at intervals over a period of 24 weeks is shown in Table III. *C. hybrida* can be expected to behave similarly. Thus a fair proportion can be expected to strike in the first two or three months, and, if adequate material is available, it might be advantageous to discard all cuttings unrooted at the end of that period and to replant with fresh cuttings.

After-treatment of Rooted Cuttings

On the Neilgherries in India [9] the cutting pots were removed into the hardening-off cases when the cuttings rooted. When hardened-off, the rooted cuttings were potted up singly into pots made of a mixture of sun-dried cow dung and sand, two inches in diameter and three and a half inches deep.

King [11] recommends that the cuttings, when thoroughly rooted, should be transplanted into thatched beds as for seedlings. Owen [16] states that cuttings should not be transplanted until they are well rooted, or they will die off.

According to Christie [4], more care is required in transplanting a young cutting than a seedling. In Russia [5], the rooted cuttings are transplanted to a bed of light soil and grown still under glass until three inches high. They are again transplanted into boxes holding 40 or more, gradually hardened off and eventually removed to the summer beds outside.

At Amani, when good strong roots at least two inches long have been produced, the young plants are transplated to a specially prepared bed of rich, sandy soil. Care must be taken to ensure that the bed is adequately drained; artificial shade must be provided. In this humid atmosphere it seems unnecessary to take special precautions for hardening-off the plants.

The young plants are best kept in the nursery until they are about nine to twelve inches high before being planted out in the field. This is specially important in the case of a shaded plantation where the drip from the shade trees during the rains will cause the death of any short, tender, young plants.

SUMMARY AND CONCLUSIONS

The advantages of vegetative propagation are discussed with cinchona species.

The history of vegetative propagation by this means is outlined.

The methods of striking root, leaf, axillary bud, hardwood and softwood stem cuttings are described. While all methods are possible, vegetative propagation by softwood stem cuttings is the most practicable and successful.

C. succirubra roots easily, but it is desirable to obtain material from stems of suckers in preference to branches. Thin cuttings of current year's growth are best.

Although open beds appear to have been used with success with *C. succirubra* in the early days, glazed propagating frames are now considered necessary to ensure efficient and uninterrupted propagation under complete control. The use of bottom heat does not appear to be necessary. During hot, sunny weather great variation in the temperature of the rooting medium is shown; this can be reduced by heavier shading.

In the early days, a layer of sand or brick dust on top of a bed of prepared soil appears to have been the accepted rooting medium.

Recently, sand alone has been used. Shallow planting is advocated. Rooting is claimed in about three weeks in Russia; elsewhere varying periods of between two to six months are required.

When all rooted, the cuttings are hardened off if necessary and then transplanted to shaded nursery beds with good drainage, where they remain until they are ready for planting into the field.

REFERENCES

[1] Adriance, G. W. and Brison, F. R. (1939).—"Propagation of Horticultural Plants". McGraw-Hill, N. York.

[2] Anon (1884).—"The Culture, Harvesting, and Drying of Cinchona", *Trop. Agric. Ceylon*, 3: 918.

[3] Bodski, S., Fogel, A., and Federov, D., (1939).—"Cinchona-growing". (Russian) *Soviet Subtropic.*, Moscow, 6: 51, cit. *Bibliog. Trop. Agric.*, 1939: 382.

[4] Christie, T. N. (1883).—Prize essay on cinchona cultivation written for the Dikoya Planters' Association, Colombo.

[5] Feilden, G. St. C., and Garner, R. J. (1940).—"Vegetative Propagation of Tropical and Sub-tropical Plantation Crops." *Tech. Comm. Imp. Bur. Plant. Crops*, 13: 30-33.

[6] Fernie, L. M. (1940).—"The Rooting of Soft-wood Cutting of Coffea arabica." *E. Afr. Agric. J.* 5: 323-329

[7] Garner, R. J. (1944).—"Propagation by Cuttings and Layers. Recent work and its application with special reference to Pome and Stone Fruits." *Tech. Comm. Imp. Bur. Hort. Plant. Crops*, 14.

[8] Gorkom, K. W. van, Transl. Jackson, B. D. (1883).—A handbook of cinchona culture. Amsterdam and London.

[9] India, Madras Presidency (1865).—"Report on the Government Cinchona Plantations and Botanical Gardens on the Neilgherries for 1864-65", *Proc. Madras Govt., Revenue Dept.*, 27th Sept. 1865.

[10] Kains, M. G., and McQuesten, L. M. (1938).—"Propagation of Plants", New York.

[11] King, G. (1880).—A Manual of Cinchona Cultivation in India, Calcutta.

[12] Kreier (Kreyer), G. K. (1938).—"The Cultivation of Cinchona in U.S.S.R." (Russia). *Soviet Subtrop.* 3 (43): 18-27, cit. *Hort. Abst.*, 8: 233.

[13] (1940).—"Cinchona Plants under Glass" (Russian). *Soviet Subtrop.* 2 (66) 53-54, cit. *Hort. Abst.*, 10: 168.

[14] Mayne, W. W., (1943).—"Notes on Cinchona Planting". *Planters' Chron.*, 38: 222-225.

[15] Moreau, R. E. (1945).—"An Annotated Bibliography of Cinchona-growing from 1883-1943", Govt. Printer, Nairobi.

[16] Owen, T. C. (1881).—The Cinchona Planters' Manual, Colombo.

[17] Stoffels, E. H. J. (1839).—"Le quinquina." *Publ. Inst. Nat. Etude Agron. Congo Belge Ser. Tech.*, 24: 34.

[18] Theunissen, R. (1929).—"Cultivation of Cinchona at Katanga". *Pan-Afr. Vet. Conf., Pretoria, 1 Aug.—17 Aug.*, 1929: 181-182.

A VETERINARY GLOSSARY OF SOME TRIBAL LANGUAGES OF TANGANYIKA TERRITORY

Compiled by P. J. Greenway from material supplied by the Department of Veterinary Science and Animal Husbandry

(*Note*.—After the English and Swahili names the tribal languages follow in alphabetical sequence according to tribes and not to the language name.)

Tribal Language and District

Swahili (*Swah.*)—Coast and Coastal Hinterland.
Arusha (*Arus.*)—Arusha.
Barabaig (*Bara.*)—Irangi.
Bena (*Bena*)—Njombe.
Burunge (*Buru.*)—Kondoa Irangi.
Chagga (*Chag.*)—Moshi.
Fipa (*Fipa*)—Ufipa.
Gogo (*Gogo*)—Dodoma.
Gorowa (*Goro.*)—(Ufiome) Mbulu.
Ha (*Ha*)—Kigoma.
Hay (*Haya*)—Bukoba.
Hehe (*Hehe*)—Iringa.
Iraqw (*Iraq.*)—Mbulu.
Jaruo (*Jaru.*)—Musoma.
Jita (*Jita*)—Musoma.
Kinga (*King.*)—Njombe.
Kizu (*Kizu*)—Musoma.
Koma (*Koma*)—Musoma.
Kuria (*Kuri.*)—Musoma.
Luri (*Luri*)—Musoma.
Masai (*Masa.*)—Masai.
Mbugwe (*Mbug.*)—Mbulu.
Meru (*Meru*)—Arusha.
Nata (*Nata*)—Musoma.
Ngureme (*Ngur.*)—Musoma.
Nguu (*Nguu*)—Morogoro.
Nyakyusa (*Nyak.*)—Tukuyu.
Nyamwanga (*Nyamwan.*)—Mbeya.
Nyamwezi (*Nyamwez.*)—Tabora.
Nyaturu (*Nyat.*)—Singida.
Nyiha (*Nyih.*)—Mbeya.
Nyiramba (*Nyir.*)—Singida.
Pimbwe (*Pimb.*)—Ufipa.
Rangi (*Rang.*)—Kondoa Irangi.
Safwa (*Safw.*)—Mbeya.
Sandawe (*Sand.*)—Kondoa.
Sangi (*Sang.*)—Mbeya.
Sukuma (*Suku.*)—Mwanza, Kwimba and Maswa.
Tusi (*Tusi*)—Kigoma.
Wanda (*Wand.*)—Mbeya.
Zanaki (*Zana.*)—Musoma.

ABORTION—
Ilbiruo (*Masa.*).

ABORTION—Contagious—
Emgi:onnarilaisho (*Masa.*).

ABSCESS—
Oltudutai (*Masa.*).

ANTHRAX—
Kimeta (*Swah.*) Geonko (*Bara.*) Kimeta (*Bena*) Bagwani (*Buru.*) Musunko (*Gogo*) Nyakabaka (*Ha*) Kimeta (*Hehe*) Chamwitumbo (*King.*) Enderit; Enger-Narua (*Masa.*) Mpingo (*Mbug.*) Thame (*Mbul.*) Kimeta (*Nyamwez.*) Konka (*Nyat.*) Nkwangu (*Nyir.*) Thuthuba (*Sand.*) Nyakabaka (Tusi).

ANUS—
Mkundu (*Swah.*) Ikurumu (*Gogo*) Mnyio (*Hehe*) Lukundu (*Nguu; Nyir.*) Ihondila (*Nyat.*) Chunu (*Rang.*).

BLACKQUARTER—
Chambavu (*Swah.*) Gioda-Awedi (*Bara.*) Chambafu (*Bena*) Matoki (*Buru.*) Utamwawa chiwoko (*Gogo*) Umnyaga (*Ha*) Chambavu; Chambafu (*Hehe*) Likoko (*King.*) Enger-Endedju; Mabarua (*Masa.*) Foroda (*Mbug.*) Tsaqwa (*Mbul.*) Kibao (*Nguu*) Genedi (*Nyat.*) Uluwile we mukhono (*Nyir.*) Matoki (*Rang.*) Thukthuk (*Sand.*) Litambango (*Sang.*) Umnyaga (*Tusi*).

BLADDER—
Kibofu (*Swah.*) Lerakoi (*Arus.*) Gisagwesega (*Bara.*) Kiputilo (*Bena*) Mabuwani (*Chag.*) Chifwanga (*Fipa*) Hungwi (*Gogo*) Soghaitumo (*Goro.*) Uluhago (*Ha*) Kiputa; Kipuuta (*Hehe*) Soghaitumo (*Iraq.*) Dagirach (*Jaru.*) Libutiro (*Jita; Luri*) Liputilo (*King.*) Esaro (*Kizu; Koma*) Ekibacha (*Kuri.*) Kesumero (*Mbug.*) Fio (*Meru*) Esaro (*Nata; Ngur.*) Iliputilo (*Nyak.*) Ichitundilo (*Nyamwan.*) Ifulijo (*Nyamwez.*) Iputilo (*Nyih.*) Kituzya (*Pimb.*) Iputilo (*Safw.*) Shiputa (*Sang.*) Uluhago (*Tusi*) Ichitundilo (*Wand.*) Ekibocha (*Zana.*).

BLOOD—
Damu (*Swah.*).

BONES—
Mifupa (*Swah.*) Fararu (*Buru.*) Ifupa (*Gogo*) Kisigo (*Hehe*) Vuha (*Nguu*) Kupa (*Nyat.*) Makupa (*Nyir.*) Makufa (*Rang.*) Ndiri (*Sand.*).

BRAIN—
Ubongo (*Swah.*) Ngaiprinyiny (*Arus.*) Kunyat (*Bara.*) Wongo (*Bena*) Tanao (*Buru.*) Urongo (*Chag.*) Uwongo (*Fipa*) Wongo (*Gogo*) Tanai (*Goro.*) Ubwonko (*Ha*) Obungu (*Haya*) Wosola (*Hehe*) Attu (*Iraq.*) Bwongo (*Jaru.*) Ubuongo (*Jita*) Uwongo (*King.*) Ubuongo (*Kizu*) Obongo (*Koma; Kuri.*) Ubuongo (*Luri*) Wongo (*Mbug.*) Urongo (*Meru*) Obongo (*Ngur.*) Ubongo (*Nguu*) Obongo (*Nata.*) Ubomba (*Nyak.*) Uwongo (*Nyamwan.*) Bongo (Nyamwez.) Wangwe (*Nyat.*) Uvongo (*Nyih.*) Wonko (*Nyir.*) Ubongo (*Pimb.*) Uwongo (*Rang.*) Uvongo (*Safw.*) Tini (*Sand.*) Uwasola

(*Sang.*) Bongo (*Suku.*) Ubwonko (*Tusi*) Uwongo (*Wand.*) Ibongo (*Zana.*).

CATARRH MALIGNANT—

Gidinghat (*Bara.*) Enger-Engati (*Masa.*) Timpa (*Mbug.*) Gidagaeki (*Mbul.*).

CHEST—

Kifua (*Swah.*) Olgoo (*Arus.*) Dakati (*Bara.*) Pamambaga (*Bena*) Mung' (*Buru.*) Kipota (*Chag.*) Isengo (*Fipa*) Mhambaga; Mpambaga (*Gogo*) Deiyo (*Goro.*) Ekikaraza (*Ha*) Ekifuba (*Haya*) Kipagula; Maambaga; Mambaga (*Hehe*) Deiyo (*Iraq.*) Agako (*Jaru.*) Echifuba (*Jita*) Ikipambaga (*King.*) Ikikuba (*Kizu*) Ekioga (*Koma*) Ikikula (*Kuri*) Ekifuba (*Luri*) Kekuva (*Mbug.*) Mbafu (*Meru*) Ekioge (*Nata; Ngur.*) Kifua (*Nguu*) Ikipambaga (*Nyak.*) Kikua (*Nyat.*) Ichifuwa (*Nyamwan.*) Kikuba (*Nyamwez.*) Ishifuva (*Nyih.*) Kikuwa (*Nyir.*) Insenge (*Pimb.*) Kipembe (*Rang.*) Ishifuva (*Safw.*) Saka (*Sand.*) Mambaga (*Sang.*) Kikuba (*Suku.*) Ekikaraza (*Tusi*) Ichifuwa (*Wand.*) Ikiase (*Zana.*).

COLIC (DONKEYS)—

Ipongit (*Masa.*).

CONTAGIOUS BOVINE PLEURO-PNEUMONIA (C.B.P.P.).—

Naweipti (*Bara.*) Ol'kipie (*Masa.*) Mpomo (*Mbug.*) Dinanamu (*Mbul.*).

CROTOLARIAN POISONING—

Ol'asasharash (*Masa.*).

CYSTS, SUBCUTANEOUS—

Enger-Imon (*Masa.*).

DIAPHRAGM—

Wambangoma (*Swah.*) Erabate (*Arus.*) Waghet (*Bara.*) Libandama (*Bena*) Kungu (*Chag.*) Luala (*Fipa*) Nhandamala (*Gogo*) Tlawi (*Goro.*) Urunyago (*Ha*) Luhago (*Haya*) Idandamala; Ludandamala (*Hehe*) Tlawi (*Iraq.*) Ndandamala (*King.*) Ngaikitira (*Meru*) Akameme (*Nyak.*) Ichiwambang'oma (*Nyamwan.*) Ibamba Ng'oma (*Nyamwez.*) Izivwo (*Nyih.*) Lwiyalila (*Pimb.*) Izivwo (*Safw.*) Lupingula (*Sang.*) Itunji (*Suku.*) Urunyago (*Tusi*) Ichiwambang'oma (*Wand.*).

EAR—

Sikio (*Swah.*) Engiok (*Arus.*) Itta (*Bara.*) Liskidza (*Bena*) Eah (*Buru.*) Kurui (*Chag.*) Ukutwi (*Fipa*) Ikutu (*Gogo*) Iya (*Goro.*) Amatwi (*Ha*) Okutwi (*Haya*) Ipulikiro; Lipukilo; Lisikisa (*Hehe*) Iya (*Iraq.*) Ite (*Jaru.*) Okutwi (*Jita.*) Imbulukitu (*King.*) Okotwe (*Kizu*) Okutwi (*Koma*) Okotwe (*Kuri.*) Okutwi (*Luri*) Koto (*Mbug.*) Kurii (*Meru*) Okoto (*Nata; Ngur.*) Gutwi (*Nguu*) Imbulukutu (*Nyak.*) Ikutwi (*Nyamwan.*) Matwi (*Nyamwez.*) Makhutwe (*Nyat.*) Ikutwi (*Nyih.*) Kituwi (*Nyir.*) Itwi (*Pimb.*) Kutu (*Rang.*) Ikutu (*Safw.*) Keke (*Sand.*) Mbulugutu (*Sang.*) Kutu (*Suku.*) Amatwi (*Tusi*) Ikutwi (*Wand.*) Okotwe (Zana.).

EYE—

Jicho (*Swah.*) Engengu (*Arus.*) Kanyanga (*Bara.*) Liho (*Bena*) Ilah (*Buru.*) Riso (*Chag.*) Liso (*Fipa*) Liso; Riso (*Gogo*) Illa (*Goro.*) Amaso (*Ha*) Elisho (*Haya*) Liho; Liko; Mihoo (*Hehe*) Illa (*Iraq.*) Wange (*Jaru.*) Eriso (*Jita*) Iliho (*King.*) Iriso (*Kizu*) Eriso (*Koma*) Iriso (*Kuri*) Eriso (*Luri*) Riso (*Mbug.*) Iriso; Kurii (*Meru*) Riso (*Nata; Ngur.*) Ziso (*Nguu*) Ikisige; Iliso (*Nyak.*) Ilinso (*Nyamwan.*) Minso (*Nyamwez.*) Ilinso (*Nyih.*) Liso (*Nyir.*) Linso (*Pimb.*) Riso (*Rang.*) Iliso (*Safw.*) C'swee (*Sand.*) Liho (*Sang.*) Liso (*Suku.*) Amaso (*Tusi*) Ilinso (*Wand.*) Eriso (*Zana.*).

FEVER—EAST COAST—

Ugonjwa wa Matezi (*Swah.*) Forot; Udonganyshek (*Bara.*) Makatu (*Bena*) Oldigana (Buru.) Kalibobo (*Ha*) Makatu; Ndigana (*Hehe*) Matuse (*King.*) Ol'tigane (*Masa.*) Ntari (*Mbug.*) Amai (*Mbul.*) Amatuse (*Nyak.*) Esakatizya (*Nyamwan.*) Uluewa; Wilwana (*Nyat.*) Amabuguzi (*Nyih.*) Matelateli; Uluwilewa (*Nyir.*) Kiririra (*Rang.*) Amabuguzi (*Safw.*) Masambatuta (*Sang.*) Kalibobo (*Tusi*) Esakatizya (*Wand.*).

FEVER—EAST COAST PLUS PNEUMONIA—

Ol'tigane Onyore (*Masa.*).

FEVER—RED WATER—

Odofojani (*Bara.*) Munyulila; Sakami; Utunele (*Gogo*) Msango wa idanda (*Hehe*) Enger-Lodugula; Osseritit (*Masa.*) Odofajani (*Mbul.*).

FOOT AND MOUTH DISEASE—

Salapta (*Bara.*) Thankao (*Buru.*) Amaula (*Fipa*) Chahola (*Gogo*) Utambwa wa Magulu (*Hehe*) Ol'lairobi (*Masa.*) Salafita (*Mbug.*) Goho (*Mbul.*) Nyegenjwa; Lufulalo (*Nguu*) Gwahu (*Nyat.*) Malonda (*Nyir.*) Kwaho (*Rang.*) Mkamasi (*Sand.*).

FRACTURES—

Itigili (*Masa.*).

FRACTURES—GREENSTICK—

Iperai (*Masa.*).

GALL-BLADDER—

Mfuko wa Nyongo; Nyongo (*Swah.*) Oledue (*Arus.*) Bidanwenda (*Bara.*) Myongo (*Bena*) Nduu (*Chag.*) Nyengo (*Fipa*) Rungwe (*Gogo*) Sughi (*Goro.*) Kasabo (*Ha*) Andulwe (*Haya*) Kinyongo (*Hehe*) Sughi (*Iraq.*) Keteni (*Jaru.*)

Omonyo (*Jita*) Endoro (*Kizu*) Indoro (*Koma*) Nyongo (*King.*) Endurwe (*Kuri; Luri*) Kesongo (*Mbug.*) Udo (*Meru*) Ondoro (*Nata*) Endwe (*Ngur.*) Inyongo (*Nyak.; Nyamwan.*) Ndulila (*Nyamwez.*) Inyongo (*Nyih.*) Kanyongo; Ketulukidyo (*Pimb.*) Inyongo (*Safw.*) Shinyongo (*Sang.*) Ndulu (*Suku.*) Kasabo (*Tusi*) Inyongo (*Wand.*) Endurwe (*Zana.*).

GLAND—

Tezi (*Swah.*) Inhelanhezi (*Gogo*) Gutezi (*Hehe*).

GLAND, LYMPHATIC—

Olngaringari (*Arus.*) Ngwaishik (*Bara.*) Ndiyenyi (*Chag.*) Amu (*Goro.*) Amai (*Iraq.*) Agenga (*Jaru.*) Ritubi (*Jita*) Akababe (*Kizu*) Amakababe (*Koma*) Engwina (*Kuri.*) Ikitubi (*Luri*) Ntari (*Mbug.*) Ngaringari (*Meru*) Akababe (*Nata*) Makababe (*Ngur.*) Ikitubi (*Zana.*).

GLAND, PRECRURAL—

Tezi la Papa (*Swah.*) Ngaringari Emuro (*Arus.*) Munyweskit (*Bara.*) Makatu (*Bena*) Ama (*Goro.*) Fumbi (*Haya*) Fetesa (*Hehe*) Ami (*Iraq.*) Ikitezi (*King.*) Nteri (*Mbug.*) Ngaringari ya sungo (*Meru*) Indesi (*Nyak.*) Inteso (*Nyamwan.*) Lyambazu (*Nyih.*) Lyambamba (*Safw.*) Kitesi (*Sang.*) Itenji (*Suku.*) Inteso (*Wand.*).

GLAND, PRESCAPULAR—

Tezi la Bega (*Swah.*) Ngaringari Ongeju (*Arus.*) Munyweskit (*Bara.*) Makati (*Bena*) Ndiyenyi ya Nzingenyi (*Chag.*) Ifyo (*Fipa*) Amu (*Goro.*) Ifumbi (*Haya*) Fitesa (*Hehe*) Ami (*Iraq.*) Ikitezi (*King.*) Nteri (*Mbug.*) Ngaringari ya sungo (*Meru*) Indesi (*Nyak.*) Inteso (*Nyamwan.*) Lyambazu (*Nyih.*) Ifyo (*Pimb.*) Lyambamba (*Safw.*) Kitesi (*Sang.*) Matenji (*Suku.*) Inteso (*Wand.*).

GUMS—

Fizi (*Swah.*) Matino (*Gogo*) Lutino (*Hehe*) Ufizi (*Nguu*) Mtino (*Nyir.*) Ufifi (*Rang.*).

HÆMORRHAGIC SEPTICAEMIA—

Enger-Labarua (*Masa.*).

HAIR—

Nywele (*Swah.*) Chuba (*Buru.*) Vili (*Gogo*) Fwili (*Hehe*) Fili (*Nguu*) Njii; Tuka (*Nyat.*) Mauli; Ntumbi (*Nyir.*) Njwire (*Rang.*) N'duw (*Sand.*).

HEAD—

Kichwa (*Swah.*) Elakunya (*Arus.*) Uhueda (*Bara.*) Mutwe (*Bena*) Saya (*Buru.*) Mroe (*Chag.*) Untwe (*Fipa*) Mtwe; Mutwe (*Gogo*) Sagga (*Goro.*) Umutwe (*Ha*) Umuntwe (*Haya*) Mtwe; Mutwe (*Hehe*) Sagga (*Iraq.*) Wiche (*Jaru.*) Omutwe (*Jita*) Untwe (*King.*) Umutwe (*Kizu*) Omutwe (*Koma*) Omotwe (*Kuri.*) Omutwe (*Luri*) Mwetwe (*Mbug.*) Mrue (*Meru*) Omatu (*Nata; Ngur.*) Mtwi (*Nguu*) Untu (*Nyak.*) Umutwe (*Nyamwan.*) Mtwe (*Nyamwez.*) Itwe (*Nyat.*) Umutwe (*Nyih.*) Tuwe (*Nyir.*) Umtwe (*Pimb.*) Mtuwe (*Rang.*) Itwe (*Safw.*) Chee (*Sand.*) Mutwe (*Sang.*) Ntwe (*Suku.*) Umutwe (*Tusi; Wand.*) Omutwe (*Zana.*).

HEART—

Moyo (*Swah.*) Oldau (*Arus.*) Gororot (*Bara.*) Numbula (*Bena*) Muna (*Bura.*) Ngoo (*Chag.*) Mwense; Untitwa (*Fipa*) Nhumbula; Ntumbula (*Gogo*) Muma (*Goro.*) Umutima (*Ha*) Mutima (*Haya*) Numbula; Nuumbula (*Hehe*) Muma (*Iraq.*) Adundo (*Jaru.*) Koro (*Jita*) Inumbula (*King.*) Enkoro (*Kizu*) Ekoro (*Koma*) Enkora (*Kuri.*) Umutima (*Luri*) Nkolo (*Mbug.*) Ngoo (*Meru*) Enkoro (*Nata*) Inkoro (*Ngur.*) Moyo (*Nguu*) Indumbula (*Nyak.*) Umwenzo (*Nyamwan.*) Moyo (*Nyamwez.*) Nkhoo; Enkoto (*Nyat.*) Umojo (*Nyih.*) Nkolo (*Nyir.*) Umodo (*Pimb.*) Mutima (*Rang.*) Umojo (*Safw.*) Zizida (*Sand.*) Numbula (*Sang.*) Moyo (*Suku.*) Umutima (*Tusi*) Umwenzo (*Wand.*) Ekoro (*Zana.*).

HIDE—

Ngozi; Ngozi ya Ng'ombe (*Swah.*) Olchoni (*Arus.*) Guhunakta (*Bara.*) Ningo (*Bena*) Faloh (*Buru.*) Mrongo (*Chag.*) Infusi (*Fipa*) Chingo ya Ng'ombe (*Gogo*) Kahani (*Goro.*) Luhu (*Haya*) Ng'ingo; Ningo (*Hehe*) Kahari (*Iraq.*) Pieni (*Jaru.*) Risero (*Jita*) Ingubo (*King.*) Riho (*Kizu*) Irishero (*Koma*) Riho (*Kuri.*) Lisero (*Luri*) Mumbero (*Mbug.*) Shoni (*Meru*) Ekisera (*Nata*) Ekisero (*Ngur.*) Mkingo wa Ngo'mbe (*Nguu*) Ingubo (*Nyak.*) Umukwela (*Nyamwan.*) Nkunja (*Nyat.*) Ikwembe (*Nyih.*) Mkunza wa Ng'ombe (*Nyir.*) Omufude (*Pimbe.*) Mumbero wa Mburi (*Rang.*) Ikwembe (*Safw.*) Kelemba (*Sand.*) Ningo (*Sang.*) Ndili (*Suku.*) Ikwembe (*Wand.*) Risakwa (*Zana.*).

HOOF—

Ukwato; Kwato (*Swah.*).

HORN—

Pembe (*Swah.*) Emowo (*Arus.*) Kujeweda (*Bara.*) Lupembe (*Bena*) Khadani (*Buru.*) Umembe (*Chag.*) Lupembe (*Fipa*) Ihembe (*Gogo*) Kharmo (*Goro.*) Amahembe (*Ha*) Ihembe (*Haya*) Ipembe; Lipembe; Lupembe (*Hehe*) Kharme (*Iraq.*) Dunge (*Jaru.*) Riyembe (*Jita*) Isuka (*King.*) Orohembe (*Kizu*) Oruhembe (*Koma*) Orotera (*Kuri.*) Lihembe (*Luri*) Lofembe (*Mbug.*) Wembee (*Meru*) Oruhembe (*Nata*) Hembe (*Nguu*) Orugunjara

(*Ngur.*) Ulupembe (*Nyak.; Nyamwan.*) Ipembe (*Nyamwez.*) Pembe (*Nyat.*) Ulupembe (*Nyih.*) Lupembe (*Nyir.*; *Pimb.*) Luhembe (*Rang.*) Upembe (*Safw.*) Kana (*Sand.*) Lipembe (*Sang.*) Lupembe (*Suku.*) Amahembe (*Tusi*) Ulupembe (*Wand.*) Oruhembe (*Zana.*).

HUMP—
Nundu (*Swah.*).

INTESTINES, LARGE—
Matumbo mapana; Utumbo mpana (*Swah.*) Monyet (*Arus.*) Hinendabasi (*Bara.*) Lutumbu (*Bena*) Durumia (*Buru.*) Maula gha Msenge (*Chag.*) Ila ikulu (*Fipa*) Igenzela; Lyenkata (*Gogo*) Wangi (*Goro.*) Ulusoge (*Ha*) Mala ga likwelaguru (*Haya*) Ibifigi; Lutumbu; Utumbu ukoni (*Hehe*) Wangi (*Iraq.*) Lipatara (*Jita.*) Ubutumbu (*King.*) Rigatara (*Kizu*) Ligatara (*Luri*) Ola-Unene (*Mbug.*) Ndeu Yoose (*Meru*) Utumbo mkulu (*Nguu*) Ubula ubunywamu (*Nyak.*) Amala amakula (*Nyamwan.*) Ifulu (*Nyat.*) Ubula ubupiti (*Nyih.*) Kilyombole (*Nyir.*) Ila (*Pimb.*) Mtumbu (*Rang.*) Ubula Uvilimi (*Safw.*) M'uu (*Sand.*) Lwambululu (*Sang.*) Mabula matale (*Suku.*) Ulusoge (*Tusi*) Amala amakula (*Wand.*).

INTESTINES, SMALL—
Matumbo madogo (*Swah.*) Utumbo mwembamba (*Swah.*) Monyit (*Arus.*) Hinenda noko (*Bara.*) Lutumbu (*Bena*) Wahantu (*Buru.*) Maula gha Marua (*Chag.*) Ilaiya Mpanda (*Fipa*) Utumbo; Utumbo usiriri (*Gogo*) Waghanti (*Goro.*) Ulusogegwamata (*Ha*) Malaga likwela (*Haya*) Lunyafinyi; Lutuumbu; Utumbu udodo (*Hehe*) Waghanti (*Iraq.*) Jatmbichi (*Jaru.*) Obola (*Jita*) Ulutumbu (*King.*) Abora (*Kizu*) Obora (*Koma*) Amala (*Kuri.*) Obura (*Luri*) Ola-Usesene (*Mbug.*) Ndeu Yoose (*Meru*) Abora; Obora (*Nata*) Amara (*Ngur.*) Utumbo udodo (*Nguu*) Ubula Ubusekele; Ubussekele (*Nyak.*) Amala Matichi (*Nyamwan.*) Bula (*Nyamwez.*) Malla (*Nyat.*) Ubula Ubunsi (*Nyih.*) Malama-milingo (*Nyir.*) Mbula bwampwe (*Pimb.*) Mwalulu (*Rang.*) Ubula Udodo (*Safw.*) M'nuu (*Sand.*) Utumbo (*Sang.*) Bula budo (*Suku.*) Ubula bwa Mpwe; Ulusogegwamata (*Tusi*) Amala Matichi (*Wand.*) Oboro (*Zana.*).

KIDNEY—
Figo (*Swah.*) Engoshoke; Naingurunyo (*Arus.*) Daguda-Muguri (*Bara.*) Figo (*Bena*) Gwadisia (*Buru.*) Shigho (*Chag.*) Ifyo (*Fipa*) Figo (*Gogo*) Gumbuyaya (*Goro.*) Ifigo (*Ha*) Sigo (*Haya*) Figo; Ifigo (*Hehe*) Gumbeyaya (*Iraq.*) Nyarogino (*Jaru.*) Jifigo (*Jita*) Vweneswyale (*King.*) Zihigo (*Kizu*) Ibimwomo (*Koma*) Igingiha (*Kuri.*) Jifigo (*Luri*) Kosankosa (*Mbug.*) Engurunye ya ndunyi (*Meru*) Ibimwoma (*Nata*) Ebimromo (*Ngur.*) Figo (*Nguu*) Ifigo (*Nyak.*) Imfyo (*Nyamwan.*) Nfigo (*Nyamwez.*) Mpigho (*Nyat.*) Imfigo (*Nyih.*) Mpigo (*Nyir.*) Ifyɔ (*Pimb.*) Nkwasakusa (*Rang.*) Imfigo (*Safw.*) Kunke (*Sand.*) Mfigo (*Sang.*) Figo (*Suku.*) Ifigo (*Tusi*) Imfyo (*Wand.*) Ijingiha (*Zana.*).

LEECHES, INFESTATION—
Ol'jota (*Masa.*).

LEGS—
Miguu (*Swah.*) Geshn'a (*Bara.*) Yaa (*Goro; Iraq.*) Molo (*Mbug.*).

LEG, FORE—
Mikono (*Swah.*) Emure Muroshi (*Arus.*) Ifiboko (*Bena*) Dabba (*Buru.*) Marenda ya Mbele (*Chag.*) Maksa (*Fipa*) Chiwoko; Muwoko (*Gogo*) Amaboko (*Ha*) Omukono (*Haya*) Fiboko; Iwok; Muwoko (*Hehe*) Bade (*Jaru.*) Okuboka (*Jita*) Amaboko (*King.*) Okoboko (*Kizu*) Monoka (*Koma*) Okoboka (*Kuri.*) Okubaka (*Luri*) Kirama Fanuma (*Meru*) Omukono (*Nata*) Omakono (*Ngur.*) Mkono (*Nguu*) Amalundi ga nkyeni (*Nyak.*) Amakasa (*Nyamwan.*) Mukono (*Nyamwez.*) Mukhono (*Nyat.*) Ifihono (*Nyih.*) Kekono (*Nyir.*) Maboko (*Pimb.*) Mukono (*Rang.*) Ivihono (*Safw.*) Thuu (*Sand.*) Fiboko (*Sang.*) Mkono (*Suku.*) Amaboko (*Tusi*) Amakasa (*Wand.*) Okoboka (*Zana.*).

LEG, HIND—
Mguu (*Swah.*) Ngejek Naituruk (*Arus.*) Figendo (*Bena*) Yaa (*Buru.*) Nanga (*Chag.*) Filundi (*Fipa*) Chima; Mugulu (*Gogo*) Amaguru (*Ha*) Okuguru (*Haya*) Kimaa; Fima; Igulu (*Hehe*) Tiende (*Jaru.*) Okuguru (*Jita*) Amalundi (*King.*) Okogoro (*Kizu; Koma; Kuri.*) Okuguru (*Luri*) Marembe Ambele (*Meru*) Okogoro (*Nata*) Kagoro (*Ngur.*) Kiga (*Nguu*) Amalundi ga kunyuma (*Nyak.*) Amanama (*Nyamwan.*) Magulu (*Nyamwez.*) Mughuu (*Nyat.*) Ivinama (*Nyih.*) Kiga (*Nyir.*) Vyende (*Pimb.*) Kuulu (*Rang.*) Ivisheto (*Safw.*) Kata (*Sand.*) Fima (*Sang.*) Kuguru (*Suku.*) Amaguru (*Tusi*) Amanama (*Wand.*) Okogoro (*Zana.*).

LIVER—
Ini (*Swah.*) Emonywa (*Arus.*) Doita (*Bara.*) Umutima (*Bena*) Daoyayu (*Buru.*) Rima (*Chag.*) Itima (*Fipa*) Itoga (*Gogo*) Daeyo (*Goro.*) Ikitiku (*Ha*) Ini (*Haya*) Itima; Mtima; Mutima (*Hehe*) Daeye (*Iraq.*) Chunyi (*Jaru.*) Mani (*Jita*) Untima (*King.*) Ritema (*Kizu; Koma*) Amani (*Kuri.*) Amanyi (*Luri*) Tema (*Mbug.*) Irima (*Meru*) Ritema (*Nata*) Ini

(*Nguu*) Ikinya; Untoge (*Nyak.*) Itima (*Nyamwan.; Nyamwez.*) Mahtima (*Nyat.*) Itima (*Nyih.*) Matima (*Nyir.*) Itima (*Pimb.; Rang.; Safw.*) Tasimo (*Sand.*) Mutima (*Sang.*) Itima (*Suku.*) Ikitiku (*Tusi*) Itima (*Wand.*) Amani (*Zana.*).

LIVER FLUKES—

Binyehi-mitki (*Bara.*) Ol'sokotu; Longiri (*Masa.*) Nsambari (*Mbug.*) Amanga-amanga (*Mbul.*).

LUNGS—

Mapafu; Mapupu (*Swah.*) Ilkipioo (*Arus.*) Shetkwet (*Bara.*) Mahafwa (*Bena*) Thukee (*Buru.*) Mafari (*Chag.*) Amapofwe (*Fipa*) Mapupu (*Gogo*) Humpa (*Goro.*) Ihaha (*Ha*) Bihaha (*Haya*) Mahafwa; Mapupu; Mhafua (*Hehe*) Humpu (*Iraq.*) Obob (*Jaru.*) Mahaha (*Jita*) Mahaswa (*King.*) Amasoswe (*Kizu*) Masasa (*Koma*) Amahaha (*Kuri.; Luri*) Mafefe (*Mbug.*) Marundu (*Meru*) Masoso (*Nata; Ngur.*) Mahuhu (*Nguu*) Amabagaja (*Nyak.*) Amapafwe (*Nyamwan.*) Mapupu (*Nyamwez.; Nyat.*) Amapufwa (*Nyih.*) Mapuupu (*Nyir.*) Amapofwe (*Pimb.*) Mahuhu (*Rang.*) Amapupwa (*Safw.*) Thuba (*Sand.*) Mahafwa (*Sang.*) Mabupu (*Suku.*) Ihaha (*Tusi*) Amapafwe (*Wand.*) Akara (*Zana.*).

MANGE—

Upele (*Swah.*) (sheep, goat) Nyawishet (*Bara.*) (cattle, dog) Hotha (*Buru.*) Mkunge (*Gogo*) Uluhele (*Ha*) Upele (*Hehe*) Eriri (*Masa.*) (cattle, dog) Mafere (*Mbug.*) Gohai (*Mbul.*) (cattle and dog) Hotta (*Mbul.*) Uhele (*Nguu*) Bulandi (*Nyamwez.*) Upele (*Nyat.; Nyir.*) Uhere (*Rang.*) Twasti (*Sand.*) Uluhele (*Tusi*)

MOUTH—

Kinywa; Mdomo (*Swah.*) Engutuk (*Arus.*) Kutta (*Bara.*) Mulomo (*Bena*) Afa (*Buru.*) Rumbu (*Chag.*) Kanwa (*Fipa*) Mlomo; Mulomo (*Gogo*) Affa (*Goro.*) Umunwa (*Ha*) Omunwa (*Haya*) Mulomo (*Hehe*) Affa (*Iraq.*) Ihege (*Jaru.*) Omunwa (*Jita*) Undomo (*King.*) Umunywa (*Kizu*) Manu (*Koma*) Omunywa (*Kuri.*) Omunwa (*Luri*) Molomo (*Mbug.*) Kana (*Meru*) Mnomo (*Nguu*) Omunu (*Ngur.*) Undomo (*Nyak.*) Umulomo (*Nyamwan.*) Mulomo (*Nyamwez.*) Mwomo (*Nyat.*) Umulomu (*Nyih.*) Mulomo (*Nyir.*) Ikinwa (*Pimb.*) Mlomo (*Rang.*) Ilomu (*Safw.*) N'uu (*Sand.*) Mulomo (*Sang.*) Mnomo (*Suku.*) Umunwa (*Tusi*) Umulomo (*Wand.*) Omunwa (*Zana.*).

NECK—

Shingo (*Swah.*) Emurt (*Arus.*) Katta (*Bara.*) Isingo (*Bena*) Issa (*Buru.*) Nzingo (*Chag.*) Ingalo (*Fipa*) Singo (*Gogo*) Issa (*Goro.*) Ijosi (*Ha*) Ebicha (*Haya*) Isingo; Singo (*Hehe*) Issa (*Iraq.*) Nguti (*Jaru.*) Ebicha (*Jita*) Isingo (*King.*) Eringoti (*Koma*) Rigoti (*Kizu; Kuri*) Ebigosi (*Luri*) Nchingo (*Mbug.*) Sungo (*Meru*) Erigoti (*Nata; Ngur.*) Singo (*Nguu*) Amakosi (*Nyak.*) Insingo (*Nyamwan.*) Nhingo (*Nyamwez.*) Kiingo (*Nyat.*) Insingo (*Nyih.*) Nkingo (*Nyir.*) Isingo (*Pimb.*) Nkingo (*Rang.*) Isingo (*Safw.*) G'wee (*Sand.*) Shingo (*Sang.*) Nhingo (*Suku.*) Ijosi (*Tusi*) Insingo (*Wand.*) Rigoti (*Zana.*).

NOSTRILS—

Matundu ya pua (*Swah.*) Ngumeishi (*Arus.*) Senetki; Serereko (*Bara.*) Menelo (*Bena*) Malaala (*Chag.*) Ifyulu (*Fipa*) Mhula (*Gogo*) Fokhi (*Goro.*) Izuru (*Ha*) Nyindo (*Haya*) Menero; Milyango ja mula (*Hehe*) Fokhi (*Iraq.*) Ume (*Jaru.*) Inyero (*Jita*) Imengo (*King.*) Rinyero (*Kizu*) Amanyeri (*Koma*) Linyero (*Kuri.*) Omwongo (*Luri*) Nduo-jampula (*Mbug.*) Mbuo (*Meru*) Amanyeru (*Nata*) Manyero (*Ngur.*) Ubwasi bwa mbulo (*Nyak.*) Amazinji ya mpuno (*Nyamwan.*) Nindo (*Nyamwez.*) Amandobolwi ga mpuno (*Nyih.*) Impuna (*Pimb.*) Amandobolwi ga mpulo (*Safw.*) Mula (*Sang.*) Idululu la nindo (*Suku.*) Izuru (*Tusi*) Amazinji ya mpuno (*Wand.*) Erinyero (*Zana.*).

OMENTUM—

Mafuta ya tumboni (*Swah.*) Engoshoke; Engurinyo (*Arus.*) Shaghwanga (*Bara.*) Mapama (*Bena*) Uga (*Chag.*) Chikuwa malo (*Fipa*) Mhama (*Gogo*) Wayo (*Goro.*) Ibinure (*Ha*) Impana; Mapama (*Hehe*) Way (*Iraq.*) Boor (*Jaru.*) Amafuta (*Jita; King.*) Amaguta (*Kizu*) Ekitinya (*Koma*) Ikitinya (*Kuri.*) Amafuta (*Luri*) Kesenja (*Mbug.*) Ngaikitira (*Meru*) Ikitinya (*Nata*) Gitinya (*Ngur.*) Amafuta (*Nyak.; Nyamwan.*) Lusasa (*Nyamwez.*) Amafuta (*Nyih.*) Chikubamala (*Pimb.*) Impana (*Safw.*) Mapama (*Sang.*) Ibinure (*Tusi*) Amafuta (*Wand.*) Litinya (*Zana.*).

PENIS—

Mboo; Mbolo (*Swah.*) Filka (*Buru.*) Mbolo (*Gogo*) Kidondo (*Hehe*) Mbolo (*Nguu*) Ilogha; Mkia (*Nyat.*) Kiduga (*Nyir.*) Mbolo (*Rang.*) Chuchu (*Sand.*).

RABIES—

Kichaa (*Swah.*) Gesk (*Bara.*) Kinkwira (*Buru.*) Lukware (*Gogo*) Likwale (*Hehe*) Osari (*Mbug.*) Tarhama (*Mbul.*) Chiraru (*Nguu*) Kihalli (*Nyat.*) Usali (*Nyir.*) Kisari (*Rang.*) Tuko (*Sand.*).

RIBS—

Mbavu (*Swah.*) Thababeri (*Buru.*) Mbavu (*Gogo*) Imbafu (*Hehe*) Mbavu (*Nguu*) Mbalu (*Nyat.; Nyir.*) Mbaru (*Rang.*) Ndee (*Sand.*).

RINDERPEST—
Sotoka (*Swah.*) Ushida (*Bara.*) Lurutoka (*Bena*) Imarema (*Buru.*) Sokota (*Fipa*) Lufako (*Gogo*) Rujorombo (*Ha*) Yamwirembe; Sotoka (*Hehe*) Luswa (*King.*) Ol'odwa (*Masa.*) Kinyenyeri (*Mbug.*) Ushida (*Mbul.*) Isotola (*Nyamwan.*) Sokota (*Nyamwez.; Nyat.*) Isotola (*Nyih.*) Kissila (*Nyir.*) Sokota (*Pimb.*) Kikungu (*Rang.*) Isotola (*Safw.*) Kwacho; Lusotoka (*Sang.*) Rujoromba (*Tusi*) Isotola (*Wand.*).

RINGWORM—
Olgoti (*Masa.*).

SKIN—
Ngozi; Ngozi ya mbuzi au kondoo (*Swah.*) Endovana (*Arus.*) Munda (*Bara.*) Ningo (*Bena*) Faloh (*Buru.*) Njonyi (*Chag.*) Inkwela (*Fipa*) Chigo ya mpene; Nghingo (*Gogo*) Kahari (*Goro.*) Ulusato (*Ha*) Luhu (*Haya*) Menee; Niingo; Ningo (*Hehe*) Kahari (*Iraq.*) Pien (*Jaru.*) Risera (*Jita*) Ingubo (*King.*) Risakwa (*Kizu*) Risera (*Koma*) Risakwa (*Kuri.*) Lisero (*Luri*) Mumbero (*Mbug.*) Isara (*Meru*) Irishakwa (*Nata*) Irisero (*Ngur.*) Mkingo ya mbuzi (*Nguu*) Ingubo (*Nyak.*) Umukwela (*Nyamwan.*) Ndili (*Nyamwez.*) Mkunja (*Nyat.*) Ikwembe (*Nyih.*) Mkunja wa mbuzi (*Nyir.*) Insaba (*Pimb.*) Mumbero; Ndiri (*Rang.*) Ikwembe (*Safw.*) Kelemba (*Sand.*) Ningo (*Sang.*) Ndili (*Suku.*) Ulusato (*Tusi*) Ikwembe (*Wand.*) Risera (*Zana.*).

SPLEEN—
Bandama; Wengu (*Swah.*) Endano (*Arus.*) Nawakti (*Bara.*) Ludenu (*Bena*) Baroo (*Buru.*) Urengu (*Chag.*) Nselembana; Yengo (*Fipa*) Ihela (*Gogo*) Dararamu (*Goro.*) Ulukamba (*Ha*) Rulesa (*Haya*) Isera; Libandama; Ludenu (*Hehe*) Dararamu (*Iraq.*) Adako (*Jaru.*) Riabakingu (*Jita*) Ludengu (*King.*) Orahe (*Kizu*) Orohe (*Koma; Kuri.*) Rybakunga (*Luri*) Longorere (*Mbug.*) Sheem (*Meru*) Rohe (*Nata*) Rahi (*Ngur.*) Wengu (*Nguu*) Ilibengwe (*Nyak.*) Ewengu (*Nyamwan.*) Ibela (*Nyamwez.*) Ilei (*Nyat.*) Ivatami (*Nyih.*) Kishela (*Nyir.*) Mselembana (*Pimb.*) Ivengu (*Rang.*) Llandani (*Safw.*) Amba (*Sand.*) Dandamala (*Sang.*) Ihela (*Suku.*) Ulukamba (*Tusi*) Ewengu (*Wand.*) Uruhi (*Zana.*).

STARVATION, EMACIATION—
Engitenya (*Masa.*).

STOMACH—1ST (RUMEN)—
Tumbo la kwanza (*Swah.*) Engenyori (*Arus.*) Geleda (*Bara.*) Lufu (*Bena*) Haya (*Chag.*) Lutuka (*Fipa*) Lifu (*Gogo*) Durumi (*Goro*) Urufu (*Ha*) Bwebuko (*Haya*) Lufu (*Hehe*) Durumi (*Iraq.*) Chino (*Jaru.*) Ichichu (*Jita*) Lijavilo (*King.*) Ikihu (*Kizu*) Ekehu (*Koma*) Ikihu (*Kuri.*) Ekihu (*Luri*) Ifu (*Mbug; Meru*) Ekehu (*Nata; Ngur.*) Ifu (*Nguu*) Untundubili (*Nyak.*) Uwula (*Nyamwan.*) Kipu (*Nyamwez.*) Ilufu (*Nyih.*) Puu (*Nyir.*) Ichifu (*Pimb.*) Ifu (*Rang.*) Ulufu (*Safw.*) Lufu (*Sang.*) Ikumbi itale (*Suku.*) Urufu (*Tusi*) Uwula (*Wand.*) Ikihu (*Zana.*).

STOMACH—2ND (RETICULUM)—
Tumbo la pili (*Swah.*) Monyet (*Arus.*) Salalkita (*Bara.*) Kihalilo (*Bena*) Kiroe (*Chag.*) Milomo ya Ntutwe (*Fipa*) Ituwa (*Gogo*) Meheme (*Goro.*) Nsaho (*Ha*) Kishegusha (*Haya*) Kinyamaganga (*Hehe*) Karutome (*Iraq.*) Akwacha (*Jaru.*) Kyabalefi (*Jita*) Kinyaulongo (*King.*) Ikyabalisha (*Kizu*) Ekibarabara (*Komå; Kuri*) Kyabalefi (*Luri*) Furamaise (*Mbug.*) Maala (*Meru*) Ikyabalisha (*Nata*) Ekibarabara (*Ngur.*) Kilomo cha ifu (*Nguu*) Ulufwe (*Nyak.*) Ulutuka (*Nyamwan.*) Nsaho (*Nyamwez.*) Ulufu (*Nyih.*) Nsapo (*Nyir.*) Kimehu (*Rang.*) Ulufu (*Safw.*) Safu (*Sang.*) Kitabo (*Suku.*) Nsaho (*Tusi*) Ulutuka (*Wand.*) Ekibarisa (*Zana.*).

STOMACH—3RD (OMASUM)—
Tumbo la tatu (*Swah.*) Embunuka (*Arus.*) Hinenda (*Bara.*) Kinyaugenge (*Bena*) Guraa (*Buru.*) Kitasura (*Chag.*) Kishila (*Fipa*) Mafufui (*Goro.*) Ikitondola (*Ha*) Lufo (*Haya*) Lifulao; Lifulawe (*Hehe*) Mufufi (*Iraq.*) Duguna (*Jaru.*) Ebabarafi (*Jita*) Sumbalu (*King.*) Ikisisiga (*Kizu*) Ekesisiga (*Koma*) Ikisusunga (*Kuri.*) Kisusuga (*Luri*) Bure (*Mbug.*) Kiraza (*Meru*) Ikisisga (*Nata*) Erususuga (*Ngur.*) Kifila Mavi (*Nguu*) Kanyasanje (*Nyak.*) Ichilisya (*Nyamwan.*) Kibisa (*Nyamwez.*) Isanyanto (*Nyih.*) Kipisa (*Nyir.*) Chisemsisha (*Pimb.*) Kitasira (*Rang.*) Itutu (*Safw.*) Kaliso (*Sand.*) Shitabu (*Sang.*) Sano (*Suku.*) Ikitondola (*Tusi*) Ichilisya (*Wand.*) Kisisinga (*Zana.*).

STOMACH—4TH (ABOMASUM)—
Tumbo la nne (*Swah.*) Eminyor (*Arus.*) Hinenda (*Bara.*) Fumbo (*Bena*) Mheu (*Chag.*) Ntutwa (*Fipa*) Musunjilo (*Gogo*) Wakant Illiwa (*Goro.*) Mpindula (*Ha*) Olusha (*Haya*) Fumbo (*Hehe*) Wakant Illiwa (*Iraq.*) Lodhibori (*Jaru.*) Limeta (*King.*) Eruti (*Kizu*) Irigatara (*Kuri*) Bure (*Mbug.*) Nguru (*Meru*) Erothi (*Nata*) Eruti (*Ngur.*) Ikyongelo (*Nyak.*) Ila (*Nyamwan.*) Nsungilo (*Nyamwez.*) Ifumbwi (*Nyih.*) Musungilo (*Nyir.*) Umsungilo (*Pimb.*) Hechu (*Rang.*) Idyadya (*Safw.*) Fumbo (*Sang.*) Isungiro (*Suku.*) Mpindula (*Tusi*) Ila (*Wand.*) Iritotomwe (*Zana.*).

STOMACH ROUND "HOVEN"—
Ol'kirikiri (*Masa.*).

TAIL—
Mkia (*Swah.*) Olkidongoi (*Arus.*) Shemng'anda (*Bara.*) Umukila (*Bena*) Khaiso (*Buru.*) Mnyeti (*Chag.*) Unchola (*Fipa*) Mchila; Muchila (*Gogo*) Haiso (*Goro.*) Umulizo (*Ha*) Omukila (*Haya*) Mkila; Mukila (*Hehe*) Haiso (*Iraq.*) Yiwe (*Jaru.*) Omukira (*Jita*) Unkila (*King.*) Omokera (*Kizu*) Makera (*Koma*) Omokera (*Kuri.*) Omukira (*Luri*) Mukera (*Mbug.*) Ngiya (*Meru*) Makera (*Nata*) Mokera (*Ngur.*) Mkira (*Nguu*) Unswigala (*Nyak.*) Umusidna (*Nyamwan.*) Mkila (*Nyamwez.*) Ipumbo (*Nyat.*) Ususinka (*Nyih.*) Mkila (*Nyir.*) Umsinda (*Pimb.*) Mukira (*Rang.*) Ubinda (*Safw.*) C'wa (*Sand.*) Mushila (*Sang.*) Mkila (*Suku.*) Umulizo (*Tusi*) Umusinda (*Wand.*) Omokera (*Zana.*).

TEATS—
Chuchu (*Swah.*) Olkina (*Arus.*) Gidinka (*Bara.*) Nyaro (*Chag.*) Issema (*Goro.; Iraq.*) Ntembo (*Mbug.*) Ivele (*Meru*).

TEETH—
Meno (*Swah.; Gogo*) Mino (*Hehe*) Meno (*Nguu*) Mino (*Nyir.*) Mayewo (*Rang.*).

TESTICLE—
Pumbu (*Swah.*)

THREE-DAY SICKNESS—
Enger-Nunuk (*Masa.*).

THROAT (OESOPHAGUS)—
Koo la chakula; Umio wa chakula (*Swah.*) Olgos (*Arus.*) Mekta (*Bara.*) Mumilo (*Bena*) Unda (*Chag.*) Ntolomelo (*Fipa*) Mmelo; Mumero (*Gogo*) Heha (*Goro.*) Kijosijo (*Ha*) Mumiro (*Haya*) Mbeeta; Mumila (*Hehe*) Heha (*Iraq.*) Ramuenyi (*Jaru.*) Rimero (*Jita*) Kimilaugali (*King.*) Ekemero (*Kizu*) Irimero (*Koma*) Remero (*Kuri.*) Limilo (*Luri*) Mumero (*Mbug.*) Oroo (*Meru*) Erimero (*Nata*) Ekemero (*Ngur.*) Lunwa Mazi (*Nguu*) Ingolomilo (ja findu) (*Nyak.*) Ichikolomilo (*Nyamwan*) Ishimilo (*Nyih.*) Kimilo (*Nyir.*) Kamiansha (*Pimb.*) Mumiro (*Rang.*) Imilo (*Safw.*) Mumilo (*Sang.*) Miro (*Suku.*) Kijosijo (*Tusi*) Ichokolomilo (*Wand.*) Ekimera (*Zana.*).

TONGUE—
Ulimi (*Swah.*) Olngejev (*Arus.*) Mushapta (*Bara.*) Lumili (*Bena*) Chafarang (*Buru.*) Ulimi (*Chag.*) Ululimi (*Fipa*) Lulimi; Lurimi (*Gogo*) Tsifinang (*Goro.*) Ululimi (*Ha*) Olulimi (*Haya*) Lulimi; Lunyago (*Hehe*) Tsifinang (*Iraq.*) Lep (*Jaru.*) Olurimi (*Jita*) Ululimi (*King.*) Ororeme (*Kizu; Koma*) Ororemi (*Kuri*) Orurimi (*Luri*) Lorine (*Mbug.*) Ulimi (*Meru*) Ororemi (*Nata*) Ororeme (*Ngur.*) Lurimi (*Nguu*) Ululimi (*Nyak.; Nyamwan.*) Lulimi (*Nyamwez.*) Ulimi (*Nyat.*) Uvulimi (*Nyih.*) Lulimi (*Nyir.*) Ululimi (*Pimb.*) Lurimi (*Rang.*) Umili (*Safw.*) T'tee (*Sand.*) Lulimi (*Sang.; Suku.*) Ululimi (*Tusi; Wand.*) Ororeme (*Zana.*).

TRYPANOSOMIASIS—
Ugonjwa wa Ndorobo; Ndorobo; Malale (*Swah.*) Garet (*Bara.*) Kesenzizi (*Bena*) Thikaya (*Buru.*) Ntikavihanga (*Gogo*) Ubuganga (*Ha*) Utamwa wa vihanga; Kisinzizi (*Hehe*) Kitamu cha Mahengenye (*King.*) Enger-Engare; Ndarobo (*Masa.*) Ngiya (*Mbug.*) Seha (*Mbul.*) Mpanje (*Nguu*) Ngi (*Nyamwez.*) Tika (*Nyat.*) Ntika (*Nyir.*) Ntaka (*Rang.*) Ndorobo (*Sand.*) Utamu gwa Mahanga (*Sang.*) Ubuganga (*Tusi*).

TUBERCULOSIS—
Kifua kikuu (*Swah.*) Getakatki (*Bara.*) Thohodina (*Buru.*) Nkohola ya lwehela (*Gogo*) Ngohomola (*Hehe*) Mpomo (*Mbug.*) Taghtendoiyo (*Mbul.*) Kifua chikuu (*Nguu*) Chechea (*Nyat.*) Kisepela (*Nyir.*) Kimpumu (*Rang.*) Kipumu (*Sand.*).

UDDER—
Kiwele (*Swah.*) Enyowa (*Arus.*) Kang'arijot (*Bara.*) Wee (*Chag.*) Irang (*Goro.; Iraq.*) Kemire (*Mbug.*) Kibocho (*Meru*).

VAGINA—
Kuma; Uke (*Swah.*) Enguset (*Arus.*) Hangiwastajata (*Bara.*) Kinena (*Bena*) Kimasi kya umbe (*Chag.*) Inyo (*Fipa*) Nghuma (*Gogo*) Aya (*Goro.*) Umutingi (*Ha*) Emana (*Haya*) Kibegi; Kikuma; Likuma (*Hehe*) Aya (*Iraq.*) Pieri (*Jaru.*) Imana (*Jita*) Kikuma (*King.*) Obokari (*Kizu*) Ubukari (*Koma; Kuri.*) Imana (*Luri*) Oka (*Mbug.*) Saameri (*Meru*) Ubukari (*Nata*) Obokari (*Ngur.*) Ubukikulu (*Nyak.*) Inyo; Ichinyo (*Nyamwan.*) Nyo (*Nyamwez.*) Impundo (*Nyih.*) Inyo (*Pimb.*) Impundo (*Safw.*) Nkuma (*Sang.*) Bukima; Nyo (*Suku.*) Umutinga (*Tusi*) Ichingo; Inyo (*Wand.*) Bukari (*Zana.*).

VULVA—
Midomo ya kuma; Mashavu ya kuma (*Swah.*) Elbeleny (*Arus.*) Hangiwastajata (*Bara.*) Kitundilo (*Bena*) Masembe (*Chag.*) Matama ya Nyo (*Fipa*) Chipwi (*Gogo*) Nethaa (*Goro.*) Kitundili; Ufula (*Hehe*) Nethaa (*Iraq.*) Chuo; Nyemechuo (*Jaru.*) Imboro (*Jita*) Kitundilo (*King.*) Ubusubi (*Kizu*) Busube (*Koma*) Uchacha (*Kuri*) Imboro (*Luri*) Oka (*Mbug.*) Mabole (*Meru*) Busube (*Nata*) Ubusube (*Ngur.*) Ilisambi (*Nyak.*) Imilomo ya Nyo (*Nyamwan.*) Matama ga Nyo (*Nyamwez.*) Ilomu lya mpundo (*Nyih.*) Matama ga Nyo (*Pimb.*) Llomu lyi Mpundo (*Safw.*) Shijonyo (*Sang.*) Imilomo ya Nyo (*Wand.*) Ubusube (*Zana.*).

WHITE SCOUR (CALVES)—
Eroti (*Masa.*).

WINDPIPE (TRACHEA)—
Koo la hewa (*Swah.*) Olgoslangijeve (*Arus.*) Moktahaw (*Bara.*) Mumila gwa muja (*Bena*) Igorogoro (*Chag.*) Undongomilo (*Fipa*) Itundu melo (*Gogo*) Gugi (*Goro.*) Kichogochogo (*Ha*) Mumilo (*Haya*) Iteguzi; Mubeta (*Hehe*) Gugi (*Iraq.*) Ramuonyi (*Jaru.*) Limiro (*Jita*) Likolomelo (*King.*) Rimero (*Kizu*) Ekemero (*Koma; Kuri.*) Limero (*Luri*) Nyangu (*Mbug.*) Ikorokoro (*Meru*) Ekemero (*Nata*) Kamero (*Ngur.*) Ingolomelo ja mbepo (*Nyak.*) Ichinkolomilo (*Nyamwan.*) Mhoko (*Nyamwez.*) Imilo ilya kutujila (*Nyih.*) Ilongomilo (*Pimb.*) Imilolya tujile (*Safw.*) Mumilo gwa mepo (*Sang.*) Weshemelo (*Suku.*) Kichogohogo (*Tusi*) Ichikolomilo (*Wand.*) Omonyo (*Zana.*)

WOMB (UTERUS)—
Mfuko wa Uzazi (*Swah.*) Endo (*Arus.*) Hangiwastajata (*Bara.*) Livaho (*Bena*) Mshiiri (*Chag.*) Chemitupa (*Fipa*) Ibichi (*Gogo*) Dighawaila (*Goro.*) Muhiza (*Ha*) Enda (*Haya*) Ivaho; Livaho (*Hehe*) Doghwaila (*Iraq.*) Lipapilo (*King.*) Iritongero (*Kizu*) Ubutingiro (*Luri*) Kilalero sha Mwana (*Mbug.*) Uruu (*Meru*) Kitele kya Mbepo (*Nyak.*) Ichipafi (*Nyamwan.*) Ipapilo (*Nyih.*) Chenitupa (*Pimb.*) Ipapilo (*Safw.*) Livaho (*Sang.*) Itungilo (*Suku.*) Muhiza (*Tusi*) Ichipafi (*Wand.*)

WORMS—HELMINTHIASIS (DONKEYS)—
Ilpoduk (*Masa.*).

WORMS—ROUNDWORMS—
Michango (*Swah.*) Giririka (*Bara.*) Dethimo (*Buru.*) Nzoka (*Hehe*) Ntako (*Mbug.*) Giririki (*Mbul.*) Majoka (*Nyat.*) Ntine (*Nyir.*) Misango (*Nguu*) Kinyululu (*Rang.*) Direebase (*Sand.*).

WORMS—TAPEWORMS—
Nyoka tumboni; Tegu (*Swah.*) Ndileho (*Buru.*) Nthakwi (*Gogo*) Ndwiga (*Hehe*) Misango; Utaku (*Nguu*) Majokha (*Nyat.*) Nzoka ya Munda (*Nyir.*) Nonju (*Rang.*) Diree (*Sand.*).

WOUNDS (FRESH)—
Ol'bayi (*Masa.*).

WOUNDS (SCARS)—
Ingiporo (*Masa.*).

Many appear to think that you have only to "industrialize" to bring prosperity. Industrialization may not in itself be altogether undesirable, but it is certain that it has not always brought happiness in its train—and surely prosperity without happiness is an empty thing—for though it has brought riches to some, it has often brought poverty and suffering for many, while the problem of the deadening effect of mass-production on the minds of men has become a very real one. Large schemes certainly *sound* well, but there are other things more essential to the life of man than electricity! Before the war, the most prosperous and happy countries were certainly not necessarily those most industrialized. The Scandinavian countries and Denmark seemed to be among those that had come nearest to the secret of successful living. True there is another side to this, namely that a small nation living to itself, without world-wide responsibilities, can concentrate on its own internal welfare. But the fact remains that a country can be agricultural or mainly so and at the same time hold its own in the world and bring great happiness to its people.

Farm and Forest (Nigeria)
Vol. VI, No. 2, pp. 55–56, 1945.

THE ONE-WAY DISC—A NEW IMPLEMENT

The Editor, East African Agricultural Journal.

DEAR SIR,

The one-way disc, which I saw on a recent flying trip to Alberta, Canada, appears to be closely linked with Edward H. Faulkner's "Ploughman's Folly" (page 81): it is the *dry-farming* tool for which he was searching. This heavy implement is well out of the class of the experimental machine, indeed I was told by one internationally-known implement house that one-way discs were selling in comparison with mouldboard ploughs in a ratio of 20:1; this at a price of around six hundred dollars apiece.

The machine consists essentially of a series of concave discs some two feet or slightly more in diameter set on a free shaft at intervals of nine inches, the whole contraption being dragged on a three-wheeled suspension at an angle somewhat similar to one side of the ordinary single disc-harrow; it is made in widths of from 4½ ft. to 10 ft. Frequently a seed box is placed on the top of the discs so that seeding and discing may be carried out simultaneously. This practice is not, however, very desirable as the uneven depth of seeding results in irregular germination, it is better to follow the one-way disc with the seed-drill in the usual way. On occasion a packer is hooked on behind, and sometimes the disc is drawn after the harvester, or again one of its commonest uses is in the preparation of summer-fallow.

Its powers of penetration even on hardish ground are good enough and under control; it loosens but does not bury too deeply the weeds and trash and it leaves the weeds on the surface to dry out. The weeds are not buried, as is the case with the mouldboard plough, they are left temporarily on the surface where ready germination takes place. This is a culture method which is quick and relatively cheap, it is one which does not damage nor excessively pulverize the soil, nor does it turn it upside down as is the case with the mouldboard plough. Furthermore, it does not leave the field lined with a series of drainage channels as does the ordinary disc-harrow. It is intended for use on properly cleaned fields in a similar manner to a single-disc.

Concerning the merits and demerits of Faulkner's reasoning I am not arguing as this letter is intended to be factual, but it is notable that one of his strongest critics, Professor Truog, of Wisconsin, admits that "of course there are certain conditions where ploughing is not advisable. For example, when hilly pasture land is to be reseeded, it is often desirable to disc rather than to plough, so as to lessen the danger of erosion. And in the dust bowl, surface tillage, leaving the trash at the surface, is recommended in order to help the soil absorb water during heavy downpours, and also to prevent the wind and water erosion that would result from too much disturbance of the surface layer". He, it is thought, is speaking of the ordinary disc and not of a one-way disc which is a much stronger and deeper tilling implement.

I have heard the one-way disc method criticized, as was Bohanan's duckfoot cultivator system, to which I drew attention on page 36 of your July, 1945, issue, as leaving a sub-surface hardpan which requires ploughing at five-yearly intervals; I do not know if this is true.

The one-way disc seems to me to be an implement with a future, and so, with your permission, I invite your readers' attention to it and leave the matter in their hands.

Yours faithfully,
EDWARD F. PECK.

AGRONOMY*

By H. C. Trumble, M.Agr.Sc., D.Sc., Waite Agricultural Research Institute, Adelaide, South Australia

The term "agronomy" has not long been employed in Australia, although it has been common enough in the United States since the beginning of the present century.

So much confusion has existed and appears still to exist in our own country as to the nature of agronomy and the field it can justifiably cover, that an attempt is made here to define the subject as a branch of scientific research in agriculture under Australian conditions.

According to the Oxford Dictionary, agronomy connotes the management of land or rural economy, and its use in that sense has dated from 1814. It appeared to have been derived from the Greek *agros*, a field, and *nomos*, management. *Nomos* signifies, in the original meaning, custom or law, leading to management in the case of a field. *Nomós* indicates a pasture or district. There is a Greek word *agronomos*, overseer of the public lands, and this is in line with the national responsibilities associated with agronomy, as interpreted, e.g. in the United States. Professor J. A. Prescott has made the following comment: "French usage of the term dates to the 14th century, when agronomists were defined as officers who manage any of the things outside the city in the fields. The term *nome* is an ancient one implying direction, law or management, and was given by the Greeks to an administrative unit in Egypt".

Little technical significance formerly has been attached to the term in England, but in America is has become a major subject of research and teaching in agriculture. The title of agronomist was first applied to technical workers in the United States in 1900, when three of the staff of the University of Illinois were so designated [10]. In 1902, detailed descriptions of courses in agronomy at the agricultural colleges of Alabama, Illinois, Michigan, Minnesota, Nebraska and Ohio, and of the agricultural institute of the University of Gottingen, Germany, were made available in the United States [8].

The foundation of the American Society of Agronomy in 1907 led to a vigorous development of the subject as a field science, and this was attended by an equally rapid growth of agronomic personnel.

From the outset, agronomy dealt with the inter-relations between soils and crops. Much work had been carried out previously on these problems in Europe, and to a lesser degree in America; but up to that stage greatest stress appears to have been placed on the soil, as it affected plant growth. The move to establish agronomy as a cognate science was the outcome of a shift in emphasis towards the plant, in its relation to the many factors of soil, climate and management which influenced its growth and development.

It has always been considered that agronomy is an applied science and that the agronomist is required to fill a practical function. The development of agronomy has proceeded on an essentially quantitative basis, however, and agronomy has been responsible for material contributions to biology generally. According to Harris [3], workers in the so-called "pure sciences" have tended to consider that while they are engaged on problems germane to science, the agronomist merely applies scientific knowledge to the practical problems of agriculture. The task of applying principle to practice is in itself a scientific problem, he asserts, and research in agronomy is capable of advancing knowledge in more specialized fields. With this it is not difficult to agree.

It might be stated that agronomy first developed as a typically American urge to grow "bigger and better crops" [2]. While the subject proceeded through its initial stages at a time when emphasis was placed on the increase of production *per se*, attention invariably has been devoted to the maintenance and improvement of soil resources.

The earliest activities of American agronomy were those concerned with the testing of varieties, the breeding of improved plant types and cultural, rotation and fertilizer tests with the more important farm crops [6].

Although incalculable labour was expended in the collection of taxonomic and experimental data, much of the work tended to be empirical, and this was encouraged by the fact that the earlier tests were conducted in an era of description and classification in scientific work generally.

During the past twenty years agronomy in America has entered a new phase in which

* Extract from *The Journal of the Australian Institute of Agricultural Science*, Vol. 9, pp. 167-173, 1943.

its basis has become ecological and physiological. Stress has been placed more and more on the relation between organism and environment; and in coming to see the numerous facets and their interplay in the integrated whole which represents his true agronomic problem, the agronomist finds himself at a cross-roads [2] or meeting place of several or many specialized sciences. He can then, if he wishes, choose one of three courses: (*a*) retain a broad, generalized, scientifically superficial but none the less useful knowledge of his problems; (*b*) become specialized in and restricted to a narrowed aspect of the field; (*c*) attempt to combine breadth with advanced research in a selected field of science, which is not easy.

Since about 1935, when far-reaching legislation was passed to promote soil conservation, agronomy in the United States has become directed more and more to soil-building problems; and this has resulted in a newly-awakened interest in pasture work.

By convention, the agronomist has generally been associated with the word "crop". Apart from natural grazings, or "range" country, the farm animal in America depends primarily on the "forage crop", grown for hand-feeding, and on grains and other concentrates. This is due to the long periods in winter during which growth is impossible and stock require to be housed, the cultivable nature and natural fertility of the soils in most higher rainfall areas, and a rapid crop-like growth in summer, resulting from a combination of favourable temperatures, long days and liberal summer rainfall.

For this reason perhaps cultivated pastures for permanent grazing have been relatively rare and the term "agrostologist" has been little employed except in relation to the taxonomy of the Gramineæ, wherein it has its original accepted meaning. In Australia we have used the term "agrostology" and "agronomy" to cover the same type of work in what is essentially pasture ecology, and with a certain amount of confusion to a great many people, to whom each term has been rather foreign.

With the increasing interest of American agronomists in pasture work it is not likely that they will style themselves agronomists.

Although much that could be termed agronomy has proceeded in Great Britain, the term has as yet been little employed in that country. Scientific work in agriculture prior to the present war appeared to proceed along narrow channels, with relatively poor integration, restricted co-operation among workers and limited application of much scientific work to the practical problem. This did not apply to all centres of investigation, and it is certain that marked changes have occurred in Britain during the course of the war. The work at Aberystwyth has freely been termed agronomic by its late Director; at Oxford the term rural economy is used; at Cambridge and most other British centres the traditional and all-embracing term "agriculture" has been retained. At Rothamsted, recent advances of importance to agronomy have been made in statistics and field experimental technique on the one hand, and in plant physiology on the other. At this centre, however, the term agronomist has rarely been employed.

Some thought-provoking views regarding the nature of agronomy have been expressed by Stapledon [5], who has given it as his opinion that no problems demand such "prolonged and large-scale agronomical investigation" as those of grassland.

Stapledon points out that research in agronomy is primarily research in the field, and that its major aim should be "to study all the factors which are operative at once and together, and in their natural interplay". He draws a distinction, however, between agronomic research and scientific research, the latter qualified, it is true, in the terms "as normally understood and conducted". With this distinction one cannot agree. Agronomy as it is being developed in Australia, is essentially scientific, both in approach and in method; its existence depends, as that of the Royal Society of England was once stated to depend, on the acceptance of the view that knowledge is to be gained by experiment.

What Stapledon deplores, in his separation of agronomical research from "scientific research as normally understood and conducted", is the glorification of statistical methods for their own sake, which, he states, has tended to "obscure the wood for the trees, to concentrate on the part (yield, for example) instead of the whole". He avers that "the technique of agronomical research entails a great deal more than blindly following all the elaborate rules and regulations laid down by the statisticians", that in his capacity as an agronomist he has been responsible for the setting up of hundreds of weird little field experiments involving in all literally thousands of plots, naturally to answer thousands of

inter-related questions. In this there is much wisdom.

Stapledon concludes "that the greatest and final hope (for agricultural betterment) is the farmer himself, for he is at least untrammelled by the technique of science and is not a slave to the fashions current in science, while his major training is not in collecting data, but in the gentle art of unadulterated observation".

With Stapledon's views one may or may not agree, but at least they are stimulating. Progress in grassland work owes much to these thousands of weird little experiments; yet it also owes much, and is likely to owe more, to statistics, which Stapledon so obviously distrusts, but which, for all he says, must be the major tool or weapon, if not the basis, of sound agronomic research.

Let us take Stapledon's views and his warnings and attempt to mould them into a logical and essentially scientific approach. It seems that we must arrive from this to the five essential steps of accepted scientific method, as outlined by Brierley [1], namely:—

(1) Observation.

(2) Perception of relationship.

(3) Inductive reasoning leading to a provisional working hypothesis.

(4) Experimental testing of hypothesis.

(5) Elevation of the confirmed hypothesis to principles of generality.

The farmer, in whom Stapledon places such store, and to whom we all look, with justification, for guidance, is well able to pursue the first three steps, which it is the right of anybody else, after all, to traverse; and he may also by confirming in practice and extending to general use the knowledge established by experiment do much to implement the fifth. But it is in the fourth, namely the experimental testing of hypotheses, that the agronomist finds his greatest scope.

We need to stress a number of facts which relate to the application of the method outlined above.

The agronomist is faced primarily with a practical problem to which economic considerations are usually attached.

The investigation of this problem in the field, where there is an uncontrollable setting, may be more difficult than in the laboratory or the glasshouse.

The investigation does not seek only to apply scientific knowledge to the practical problem, but seeks also to establish new knowledge.

While observation and experiment are both indispensable, their importance is outweighed by original and creative thought.

The results of scientific work can be expressed in language intelligible to the farmer or the layman. Agronomists do not find this difficult, owing to their everyday contacts with agricultural practice; but because of this very fact, the work of the agronomist has sometimes been regarded as unscientific. In my own view, agronomy should aim at the highest level of intellectual attainment possible, but as Brierley [1] has pointed out, we are not pure intellects but men and women in a work-a-day world, with all its human contacts.

An understanding of ecology is basic to agronomy, because our agricultural problem is invariably the question of the relationship between an organism and its environment. The organism may be plant or animal, the improvement of which is a matter of selection and breeding; or it may be a plant-animal complex, as in the case of the pasture in its relation to animal production; or it may be the human community as governed by climate and soil, food supply, aesthetic value of surroundings and various sociological considerations. Whatever our problem, we can separate our organism on the one hand from its environmental complex on the other.

It follows that a knowledge of climatology, soils and biology is essential; but the necessity for quantitative evaluation places statistics also as an indispensable tool, and like any highly specialized and complicated piece of machinery, statistics require to be understood and experienced in practice before one can hope to make effective use of it. But it is equally important that the purpose for which the tool is being used is as thoroughly appreciated. I have known specialized workers to approach the statistician for assistance in a climatological problem, of which neither could possibly see the real implications. If the agronomist were consulted, in eclectic matters of this kind, both orientation and objective could in many cases be more clearly defined, and the statistician better able to suggest a suitable method for the real problem.

One should not place statistics as the first scientific need of agronomy, because that is unquestionably ecology in its most fundamental sense. But once ecological approach

and experience have been gained, statistics become indispensable to the measurement of the factors whose significance has become recognized, and as previously pointed out [9], the key to our approach is via R. A. Fisher's Analysis of Variance, which enables the variance as it occurs in the field to be measured and accepted as a whole, but partitioned for rigorous sub-measurement, into its component parts and their interactions.

The mutual inter-relations and interdependence of agronomy and plant physiology have been much stressed in America; and it has been pointed out that physiology was born in an agricultural academy [4]. Hottes maintains that plant physiology continued to prosper for a time after it had been divorced from its early associations, but retrogressed as intensive studies of specific functions unrelated to the natural phenomena of the field were pursued.

The degree and ease of control to be obtained in pot cultures and the laboratory have encouraged the plant physiologist to disregard the ecological complex to which his specific problem is related; the agronomist can help to ensure that investigations of physiological function retain a sufficient bearing on major field problems.

A high level of plant physiological understanding appears to be the general rule among workers in agronomy in the United States. The trend away from routine tests of variety and crop management to investigations of climatological and nutritional factors in relation to plant growth and composition has made this inevitable.

It has already been pointed out that agronomy stands at a cross-roads of the specialized sciences which relate to agriculture. Agronomists, therefore, by concentrating on a particular aspect of an agronomic problem, may enter such fields as those of climatology, soil chemistry or physics, microbiology, physiology, plant biochemistry, statistics, genetics, taxonomy, economics, etc. It is held in the United States that the greatest advances in knowledge have been made through increased specialization [2]; but care is taken to preserve balance by means of organized co-operation.

This has been achieved in America by fostering successfully unselfishness and the give and take principle, which in that country rarely means "you give and I take". Unfortunately, in Australia there has in the past been much of this latter form of exchange, and there are some workers who seem constantly to be governed by a fear that their very thoughts will be taken from them and mercilessly exploited.

Just as an agronomist may become highly specialized in a single narrow field, so may a specialized worker by broadening his interests enter the field of general agronomy. The latter is the much more difficult course, however, and is impossible unless considerable practical experience and awareness of agriculture and an ecological outlook have been gained. In all work that seeks to be carried out under the guise of agricultural science, it seems that there is a moral responsibility on the part of the investigator to maintain one eye at least on the practical problem. Otherwise he might just as well leave the realm of agriculture and openly follow the course to which he is intellectually wedded.

Whatever the degree of specialization followed, there will always remain in agricultural research generally, and in agronomic work in particular, the necessity for planned co-operation, and the success attained in this direction largely depends on factors of personnel.

Professional jealousy and institutional pride have long been marked as the main bugbears of co-operative effort.

While active antagonism can hardly be termed rife in Australia, there has been much self-centred indifference and some tendency to follow a personal bias or to secure personal advantage to the detriment of general progress. There is room for a greater acceptance of the right of all workers to enter any field in which they are likely to help, and a realization that helpfulness or sacrifice on the part of the individual scientist must react to the benefit of that individual also.

The conclusion may be drawn, then, that co-ordinated work is necessary in agronomy. While detailed understanding can only be secured by advanced specialized investigation, it is still equally true that the intricate complex of factors common to most agricultural problems requires efficient teamwork.

The following is the writer's viewpoint of the subject, as it is tending to be developed in Australia.

Agronomy is essentially a field science and endeavours to assess the problems of field husbandry, whether of crop, grassland, or both combined, in relation to ecological factors and physiological principles. It seeks to analyse the agricultural problem in terms of the many

interacting factors of soil, climate and biology, including management, and to understand the role of limiting factors in their relation to the field complex.

It is thus broad, generalized in scope, and should serve as a meeting place for more specialized sciences. Much of its ambit is co-ordinative.

Workers in agronomy should possess an advanced knowledge of ecological and physiological principle, a sound training in statistical approach and method, a knowledge of climatology, soils and economics, and a practical awareness developed from extended experience of agricultural field problems and efficient farm management. They should be capable of assessing the relative importance and significance of more specialized branches of science in relation to their own problems.

Agronomy, while assisted greatly by field observations and depending a good deal on constructive and creative thought, is required at all times to be accurately quantitative, and like any other branch of science, is based on tested, verifiable and organized knowledge. Its application reveals how much scientific progress has outstripped its social utilization, and the extent to which human activities have failed to keep pace with our widening capacity for control over nature.

Agronomists may find it necessary to augment their field work by special glasshouse or laboratory investigation; but they have learnt not to generalize from the results of researches carried out in the pot culture house or laboratory, and to rely finally on the results of their own experiments, carried out in the field [3]. The agronomist naturally, therefore, appeals to the method of plot testing. It is essential that his field experiments should be wisely planned, accurately executed and sensibly interpreted; and a sound working knowledge of statistics is as indispensable in the planning of the work as in its analysis and interpretation.

This brief review is concluded by a comment on the role agronomy might occupy in future agricultural adjustment and reconstruction in Australia.

The work of the Soils Division of the Council for Scientific and Industrial Research since 1930 has emphasized the soil survey as a primary basis for future agricultural use; and ecological analysis of the natural vegetation associated with each soil type has proved specially informative.

The land use survey must nearly always be of limited value, however, because it can only be based on what practical experience has arrived at by trial and error. It cannot point to new methods or principles, many of which only technical investigation can reveal, and on which future progress may depend.

It is obvious that the logical outcome of the soil survey is agronomic experimentation designed to determine the most effective land use or uses to which each main soil type could be put. This has occurred on a number of surveyed types in South Australia, on each of which agronomic investigation has provided factual evidence which has served as a guide to future agricultural use. Where agronomic work has not been preceded by a soil survey it is of considerably less value.

As long ago as 1915, C. E. Thorne [7], in a presidential address to the American Society of Agronomy, stated that "by the soil survey we may classify our soils on the basis of their geological history and physical characters, and thus may be enabled to limit the far more difficult and costly field experiment to general soil types, but unless the survey is followed and its findings interpreted by field experiment, it will have very little value. We may learn much by chemical analysis and by pot cultural work, but the final answer to our questions can be obtained only in the field".

Whether State or Federal services foster agronomy in the future there is much room for an enlargement of competent and adequately trained personnel for work in the field, and it is also desirable that there should be a minimum of political interference with personnel and with policies.

REFERENCES

[1] Brierley, W. B.—*Ann. Appl. Biol.*, 21: 351-378, 1934.

[2] Garber, R. J.—*J. Amer. Soc. Agron.*, 31: 933-1001, 1939.

[3] Harris, J. A.—*Ibid.*, 20: 443-454, 1928.

[4] Hottes, C. F.—*Ibid.*, 18: 60-68, 1926.

[5] Stapledon, R. C.—*Herb. Rev.*, 6: 129-145, 1938.

[6] Steece, H. M.—*J. Amer. Soc. Agron.*, 32: 135-140, 1940.

[7] Thorne, C. E.—*Ibid.*, 7: 257-265, 1915.

[8] True, A. C., and Crosby, D. J.—U.S. Dep. Agric. Off. Exp. Sta. Bul. 127, 1903.

[9] Trumble, H. C.—*J. Aust. Inst. Agric. Sci.*, 9: 49-55, 1943.

[10] Warburton, C. W.—*J. Amer. Soc. Agron.* 17: 757-764, 1925.

REVIEW

D.D.T.—THE FACTS

With the appearance on the market of commercial preparations having as their active ingredients the synthetic insecticides, the development of which received so great an impetus with the war-time shortage of pyrethrum and derris, there is need for as much accurate data regarding the physical and chemical proportions and the biological effects of these synthetics as can be obtained. In the case of dichloro-diphenyl-trichloroethane, more generally known as D.D.T., a useful summary of the available data is given in a paper prepared by the Chemical Defence Research Department of the Ministry of Supply and published by H.M. Stationery Office in January, 1946, under the title "Some Properties and Applications of D.D.T." (price 6d.).

In the brief compass of 34 pages a clear and precise compilation is presented of information on the practical applications of D.D.T. derived from published literature and reports held by various Ministries. Tables of solubility for pure D.D.T. are given together with a useful note on the composition of the commercial crude substance. The application of D.D.T. as solution, emulsion, suspension or as aerosol is then dealt with briefly, and notes given on the types of sprayers which have been used for these various purposes, based mainly on experience in the Services. The last two sections deal with the toxicity of D.D.T. to man and domestic animals, and to insect pests. Appendices tabulate some typical formulae for D.D.T. preparations, and a summary of results of field trials in the control of various insect pests.

So far, the main achievements of D.D.T. have been in the field of public health by controlling disease-carrying insects such as lice, flies and mosquitoes and so reducing the epidemics associated with man in the mass, or the disruptions of urban life common to war. The necessity for using organic solvents in order to prepare D.D.T. in solution has been no drawback here.

The use of D.D.T. for controlling plant pests is still a matter for investigation. The outlook is promising to say the least, but the work done so far has not been exhaustive, as Appendix II shows. Good control of many pests, particularly leaf-eaters, has been reported. So much, however, has been expected of D.D.T. as a result of the tremendous publicity it received, that greater interest attaches to those insects which it has so far failed to control than to those which succumb. Among the more resistant insects and related pests listed are white grubs, the Mexican bollweevil of cotton, the citrus mealybug, the *spiræa aphis,* red spider, the Dermacentor tick and slugs. The proper evaluation of the position of D.D.T. among agricultural insecticides will be helped rather than hindered by such knowledge. Practical men doubt the appearance of perfection.

Possible harmful effects from the widespread use of D.D.T. in cultivations are indirectly touched upon in the list of beneficial insects "controlled" by it. Included here are the honey bee, ladybirds, and several wasps parasitic on important pests. Further information on this topic will no doubt come from the work of the Colonial Insecticide Research Team now in Uganda.

Two later publications dealing with the same subject are "D.D.T. and other Insecticides and Repellants Developed for the Armed Forces "(U.S. Department of Agriculture, Misc. Pubn. No. 606, August, 1946) and "D.D.T. the Synthetic Insecticide" by West and Campbell (Chapman and Hall Sh. 21). The former deals with the public health aspects of D.D.T. usage mainly under war conditions. The latter is an exhaustive summary of work published so far in all the different fields.

W. V. H.

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